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INTRODUCTION TO MEDICAL SCIENCE

Introduction

to

Medical Science

by

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PREFACE

This book is planned for the course in Introduction to Medical Science. It builds on the foundation of physical and biological sciences, nutrition, materia medica, the social sciences, and nursing arts which the student has had or is having parallel with this course. It should lay the foundation for study in all clinical fields. The student, therefore, needs to use a scientific background to understand this subject; reference must be made constantly to textbooks and reference books on these basic subjects.

At the beginning of each unit, review of material already presented and necessary for the understanding of the unit is suggested. For quick reference the glossary gives definitions of most of the new words used in the book, but it is not intended to take the place of the dictionary, which should always be at hand when studying.

General review questions, projects, and references are given at the end of each unit with the intention of helping the student master the material

J. J.
H. W. N.

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INTRODUCTION TO MEDICAL SCIENCE

UNIT I

THE DEVELOPMENT OF MEDICAL SCIENCE

CHAPTER 1

AN HISTORICAL SURVEY OF MEDICAL SCIENCE

Introduction.—Modern medicine is a part of Western culture and civilization. It has developed as an intimate part of it and can be understood only in relation to it. As soon as primitive man began to think abstractly, he considered how he could avoid pain, sickness, and death. This problem has been foremost in man's mind ever since, but always has he been limited by his incomplete knowledge of nature and by his erroneous and superstitious interpretations of the facts which were known to him To some extent these limitations hold even at the present time Economic, moral, philosophical, and religious considerations have also influenced his thinking in matters medical—sometimes for the better, as when the Church encouraged the construction of hospitals for the sick, and sometimes to his detriment, as when moral censure prevented the dissection of dead bodies. For this short discourse it will be impossible to examine all of these relationships, but it must, nevertheless, be borne in mind that each step in medical progress is a product of its period which furnished the proper soil.

However, progress would not have been made if men of unusual mental powers had not been there to harvest the rich fruits as they ripened In fact, so much has this principle of individual contribution been emphasized that some histories of medicine are composed of biographical sketches of those who advanced it However, none of the great men of

some reason this concept proved extraordinarily tenacious. Many others came and went. In our present civilization there are several such "systems."

Simple Observation.—Speculative superstition dominated the healing arts in early antiquity. Thus practiced the Egyptians, the Syrians and the Babylonians, and many Oriental cultures which have survived to the present era. The first break with *this tradition* was made by the Greeks They began to study



Fig. 1—Hippocrates (460-370 B.C.). (Courtesy of Benjamin Salzer-Cecilia C Mettler Collection, Columbia University, New York City, Medichrome, Clay-Adams Co., Inc.)

nature objectively in all its branches, and the human body and its diseases are part of nature. Thus, for the first time do we find simple descriptions of the human body and its ills without attempts to invoke supernatural powers This is in line with the general aspect of ancient Greek culture at its best. In philosophy, art, and drama is also seen the endeavor to follow simple straight lines. The beauty of Greek art lies in its simplicity and in its purity. The same applies to

medicine could have made his contribution except as a member of a community which had prepared the stage on which he could act.

It shall be our purpose, briefly, to trace the most important phases of the evolution of medicine and to show how history *produced the circumstances and how gifted men molded these* into advances toward the coveted goal of freedom from the pain of sickness and postponement of death.

Speculative Superstition.—Primitive man was curiously imaginative. The facts which enabled him to reason from cause to effect were relatively few, yet his problems were many. Somehow he would not be left without an answer. So he assumed many things and his world became inhabited with gods and spirits and supernatural powers which took possession of the visible world about him. This manner of thinking was also applied to his illnesses, and as we examine the attitudes of primitive peoples toward illness, we find that very little of it is reasonable or practical. The driving out of spirits or placating evil ones takes a much more prominent part than herbs or other simple remedies which simple observation and reasoning would have shown to be helpful. Primitive as it is, this belief in forces beyond what can be explained and understood has remained an important element in man's attitude toward disease. At all times there have been unorthodox healers who have preyed upon the credulity of those who were afflicted. We see it in the mountebanks and witches of the past and in the patent medicine man of today. This element becomes more difficult to grasp as it blends with reasonable approaches and professedly "scientific" explanations and becomes part of systems of healing The last century or two abounds with such phenomena. Mesmerism, "animal magnetism," spread all over Europe nearly two hundred years ago The basic element was hypnotism, a psychic phenomenon which still requires explanation, but it was so dressed up with cheap and colorful trappings that it may truthfully be called charlatanism

Then there was homeopathy which began about the end of the eighteenth century and which extends its dying remnants well into the present. Its concept was that illnesses could be cured by infinitesimal doses of drugs which would produce effects similar to the ones they were supposed to cure. For

this contributes much to his good reputation. His behavior should be that of an honest man and as such he should appear gentle and tolerant before honest men. He should not act impulsively or precipitately; he should maintain a calm and serene visage and should never be in a bad humor, but, on the other hand should not appear too gay."

Much of the clinical wisdom was condensed into the *Aphorisms*, the most famous of the Hippocratic writings. Many of the aphorisms are quoted to the present day. Best known is the first: "Life is short, and art is long; the occasion fleeting, experience fallacious and judgment difficult."

The impression made by this Greek school was tremendous, and had it been followed more closely, medicine might have advanced along a path more direct than proved to be the case. Unfortunately, Greece was overthrown. Eventually Rome became the torchbearer of Western civilization, but while the Romans were realists, their peculiar talents were not suited for the continuation of the work of Hippocrates, and when they were overthrown, the dark Middle Ages submerged Hippocratian medicine along with many other of the great treasures of the classics. The best of medicine survived and developed among the Mohammedans. Although they made many valuable contributions to medicine, none equalled in value those of the past. Arabian medicine was conveyed to medieval Western civilization through contacts made with the crusaders and the wars and other intercourse which occurred on the Iberian peninsula. So when Western civilization was ready for further advances, these treasures were in the libraries, a ready foundation.

This small introduction to medicine must limit itself to the most important data. Therefore, many valuable contributions of this era must be passed by and the interested reader is referred to standard texts on the history of medicine, of which there now are many.

The Renaissance.—As the Renaissance dawned upon the Western world, two developments profoundly influenced the evolution of medicine. Universities became organized and with them medical schools whereby both research and instruction could be carried out in a much more systematic manner. At the same time this period was characterized by a revolt against traditional authority No longer were men satisfied

medicine. The outstanding Greek physician was Hippocrates, who was born on the Island of Cos about 460 B.C. During a long life he traveled extensively over the Greek world, teaching as he went. Thus he left not only voluminous writings, but also a numerous school of disciples who for generations carried on his traditions. A very extensive literature has been left which has been attributed to Hippocrates, but much of it has been written by his students or by authors who have been influenced by him. Curiously, the knowledge of Hippocrates, to a large extent, reached the Western world through Arabian medicine, for most of the original writings were lost in the decadence that followed the collapse of Greece and Rome. Translations into Arabic remained and were translated into medieval Latin by the early Church.

The Greeks did not dissect the human body and had little knowledge of anatomy and physiology as we know it now. The Hippocratic medicine was, therefore, based on bedside observation of the patient, correlation with other similar experiences, and conclusions which could be drawn therefrom. The Greek physicians noted certain symptoms and signs, such as the periodic breathing which we now call Cheyne-Stokes respiration, and observed what happened to the patients who exhibited such signs. There was to this simple science added some theory such as the concept of the four humors—the blood, the phlegm, the yellow bile, and the black bile, representing heat, cold, dryness, and wetness—but these do not invalidate the valuable principle of clinical observation which is the important contribution of the school of Hippocrates.

Hippocrates also established a very high ethical standard for the physician. The standard was so similar to the ideals of conduct which we expect of modern physicians that the "Oath of Hippocrates" has been held as standard of conduct by physicians to the present time. It is curious to read how applicable some of the directions of these writings are to our age; for example, "He who wishes to acquire exact knowledge of the medical art should possess a natural disposition for it, should attend a good school, should receive instruction from infancy, should have the desire to work and the time to dedicate to his studies" (*On the Law*, W. H. S. Jones Translation), or (The physician) "should know how to be silent at the proper moment and should conduct a regular life, because

and the Chair of Anatomy became occupied by a succession of men whose names live forever. Most famous was Vesalius (1514-1564). He was a son of a physician and was born at Brussels. He easily manifested his extraordinary gifts and was professor at Padua from 1537-1546. During this time he produced *De humanis corporis fabrica*, an epoch-making new anatomy, one of the greatest medical books ever written. It has been called the foundation of modern medicine. From this time on the knowledge of anatomy advanced rapidly, and within a few generations gross anatomy became established as we know it now.



Fig. 2.—Vesalius (1514-1564) (Courtesy of Benjamin Salzer-Cecilia C. Mettler Collection, Columbia University, New York City; Medichrome, Clay-Adams Co., Inc.)

However, it is not enough to know how the body is built. We must also know how it functions. This is learned through the physiological experiment. With knowledge of anatomy partial, it was no wonder that knowledge of physiology was still more fragmentary. While some suggestions had been made on the subject, the manner in which the blood circulates

with the words of the ancients—they wanted to explore and see for themselves. The great voyages of discovery were a manifestation of this desire to transcend the boundaries then known to man. In science the same surge was manifested in men like Galileo, who expanded our knowledge of astronomy, but even more, he established the method of scientific inquiry, setting up principles for those who worked in other branches of the sciences. In philosophy, Francis Bacon devised the "inductive method": "All recorded facts, new observations, and experimental results were to be collected and tabulated, so that the connections between phenomena and their resultant general laws became manifest" (Castiglioni). It was inevitable that this spirit would invade the medical sciences also.

The other important development of this period was the invention of printing. For us, to whom the printed letter is a simple and inevitable part of life, it is almost inconceivable that once information spread only by the spoken and the written word. In Rome, books could be multiplied only by dictation to a class of slaves; through the Middle Ages the monasteries were the chief source of books, for there monks laboriously copied books which were changed according to their judgment and errors Now, within a few years the written work became available to a multitude of readers at greatly reduced cost. Again, it is easy to imagine how this advance would accelerate the spread of medical knowledge

The great handicap to the advancement of medical knowledge from antiquity through the Middle Ages was that very few had intelligently examined the inside of the human body. Through all the cruelty and needless waste of human lives which characterize these periods, scientific dissection was forbidden as being loathesome and a violation of the privacy of the dead Curiously this feeling survives and is frequently encountered in modern medical practice when uninformed persons object to the post-mortem examination of their relatives. Knowledge of anatomy and of pathological anatomy can advance only through examination of the dead

The spirit of the Renaissance also overcame this prejudice, and dissection of the human body was made the foundation of the exact science of human anatomy. The University of Padua became the outstanding place in this development,

physiology, and from the spirit of Renaissance generally, it *was still largely dominated by mental obfuscation and empty* verbosity; vain and vague speculations and actions dictated by them dominated medical practice. Medications, often made from animal secretions and excretions, were given because of qualities which were purely imaginative to treat conditions of which the physician's notions were equally vague. *The simple doctrines of Hippocrates, though taught,* went unheeded. It became necessary to bring clinical medicine back down to simple principles of observation and plain reasoning. The British supplied the man who was to become the new Hippocrates. Thomas Sydenham (1624-1689) was with the Round Heads in the Civil War and obtained his education at Oxford and, perhaps, at Montpellier. Because of his plain outspoken manner he was not popular among the profession of his day. He did, however, have a large practice, and he was friendly with such philosophers as John Locke, who shared his simple straightforward outlook on life. His greatest influence was upon posterity, for he became widely read and accepted during the eighteenth century. Some of his clinical descriptions were fundamental and lasting, such as his distinction between measles and scarlet fever, his description of gout and of chorea (since called Sydenham's chorea). The spirit of Sydenham was carried on by the great Boerhaave (1668-1738), one of the greatest clinicians of all times. Boerhaave practiced at Leyden, Holland. Students and patients flocked to him from all parts of the world, and he acquired fame and influence over medical practice which extended into every corner of Europe and which lasted for generations. His practice and teaching were based upon the plain teachings of Hippocrates and as such their influence has carried down to the present time.

We are now passing down through centuries where many physicians must be considered great by our measures Only a few outstanding ones can here be mentioned and must serve as examples of the rest

The Seventeenth and Eighteenth Centuries.--The principle of accurate observation and of concluding simply from experience, which had been established by Hippocrates and re-established by Sydenham, would be insufficient for the conquest of disease if it were to be limited to bedside observa-

was not understood in 1600. William Harvey (1578-1657), an English physician, had studied at Padua, after which he returned to London where he achieved considerable prominence, though his practice never became large. His fame is founded upon his studies on the mechanics of the circulation; by means of animal experiments he demonstrated the course of the blood through the body, back to the right heart, through the lungs, and back to the left heart and that the heart acted



Fig. 3.—William Harvey (1578-1657) (Courtesy of Benjamin Salzer-Cecilia C. Mettler Collection, Columbia University, New York City, Medichrome, Clay-Adams Co, Inc)

as a pump which kept it circulating His famous book, *De motu cordis et sanguinis in animalibus*, came out in 1628. It not only was a great contribution to medical knowledge, but, almost more important, it thoroughly established the method of physiological experiment upon which modern physiology rests.

One more great advance in medicine belongs to this age. Notwithstanding the encouragement to clear thinking which medical practice had received from philosophy, anatomy

systems. These have now only historical interest except insofar as they became the precursors of our modern systems such as Osler's or Nelson's and others. However, the principle of gathering and classifying medical facts in the modern sense was established in the eighteenth century.

Morgagni had his eye directed chiefly upon the organs as the site of disease, but this view was to suffer modification by the French school. However, again we must correlate world history with medical history if we are to have the proper perspective.

The kind of thinking which inspired the French philosophers of the seventeenth and eighteenth centuries and which culminated with men like Rousseau and Voltaire made the French Revolution inevitable This revolution was more than a political upheaval resulting in the abolition of monarchy and aristocracy. It ushered in a period of free and unhampered thinking and intellectual exercise. To France came the leadership in many fields, including medicine, and the medical schools, especially in Paris, drew students from all parts of the world, including North America. Some of the best men in Boston, New York, and Philadelphia in the first part of the last century had studied in Paris. The knowledge of disease and disease processes advanced both on clinical and pathological grounds. Bichat (1771-1802) made the important contribution that disease must be studied in respect to the tissues which it involves rather than the organs. This has become important in respect to many diseases such as those which involve the lymphatic system or the blood, etc. Louis introduced the statistical method in the study of disease. As simple and as obvious as this principle may seem, it is established only with difficulty to this very day. Doctors in their conclusions still tend to be swayed more by their individual observations than by the over-all experiences The cooperative studies which are now carried on in many medical fields are the outgrowth of Louis' work: Several clinics will study their cases according to certain established rules and pool their experiences in order that conclusions may be drawn which would not be possible on the basis of the material obtained from each one.

Christianity and Medicine.—The effect of the teaching of Christ upon the development of Western civilization has been

tions. Knowledge of the clinical manifestations of disease must be supplemented by knowledge of what actually happens to the organs of the body. Such knowledge can be obtained only by post-mortem examinations which to this day are essential for the progress of medicine. During the eighteenth century increasing emphasis was placed upon pathological anatomy. It reached its climax in the studies of C. B Morgagni (1682-1771), who established the principles of correlating the clinical history with post-mortem findings and of examining every organ of the body, whatever the cause of death. These are the principles which still underlie our modern pathological departments and clinical pathological conferences. Morgagni lived his active life first in Bologna and later in Padua, where he eventually acquired great fame, for his contemporaries fully recognized the value of his work, and he is still revered in Italy as one of the great men of medicine. For posterity his fame rests largely upon his great work, *De sedibus et causis morborum (On the Sites and Causes of Diseases)*. This folio consists of a number of reports of clinical case histories with post-mortem findings. Curiously, they are written in the form of letters to a young man. Several of them are still quoted, such as the case of a patient with heart block and Stokes-Adams attacks.

The seventeenth and eighteenth centuries thus saw a tremendous increase in knowledge of actual facts. Man was really looking about him and whenever he looked he saw something new. Curious men gathered stones, plants, birds, animals, and insects. They traveled and saw other countries, and the recorded facts of history continued to increase It was all very confusing. So it became necessary to establish some sort of system in all this profusion. Much of the literary work of the eighteenth century was therefore concerned with the classification and recording of facts, new and old. The "encyclopedists" endeavored to gather all known facts into big volumes. As an outgrowth of this endeavor we still have the Encyclopaedia Britannica which first came out in 1768. The Swede, Linnaeus, arranged all living creatures into a system of classes, orders, families, and species which is still in use. The "L" which often is seen following the Latin name of a plant or an animal refers to Linnaeus Similarly in medicine, men attempted to gather all known facts into large

after H. Dunant had witnessed the battle of Solferino and had written a description thereof. This led to the first international conference at Geneva, Switzerland, in 1863, after which the various countries agreed to consider as neutral the wounded and the services which cared for them. It has since among civilized countries been the custom to treat the wounded, friend and foe alike. This organization rendered an increasingly valuable service during the wars which followed during the next century.

Industrialism, Capitalism, and Medicine.—As modern medicine has developed, it has become increasingly complicated and expensive. In antiquity and the Middle Ages the doctor had little knowledge and primitive apparatus, but as medical knowledge grew and experimental medicine developed, it became increasingly expensive. It gradually became necessary to spend much time on investigation and thought. This could be done increasingly as more and more wealth was placed at the disposal of the physician. He shared in the *growing opulence of the Western world. This opulence, or* accumulation of capital, owes its origin partly to the growth of the machine and partly to the development of overseas trade following the great voyages of discoveries A machine is, generally, a device whereby more work can be accomplished by less effort.

Antiquity and the Feudal Ages knew few machines, but gradually during the seventeenth century the first crude shops were set up where men worked for others for wages, and now began the migration from the country to the city which has persisted to the present day This development gained momentum during the next century, especially in England, where the textile and pottery industries, among others, grew to become quite complex. This happened at a time when Great Britain assumed the leadership in international trade, and soon England became a wealthy nation with teeming industrial cities. The wealth favored the development of medicine, and soon the density of population created special medical problems. The laboring classes were paid poor wages and lived in overcrowded tenements, and when serious sickness affected them, they had to rely upon the community for their care As a matter of expediency hospitals were constructed for this purpose, and thus the London Hospital, the

so great that at times the two have become identified. Whether or not men accepted the dogmas and tenets of Christianity, no one in the Western world escaped its influence. The principle of love and concern for one's sick neighbor has had a profound influence upon medicine through the times. The earliest Church instructed its deacons to call upon the sick. The monasteries and the convents of the Middle Ages became refuges of the sick. As the Crusaders visited the countries of the Orient, they found there hospitals as part of Arabian medicine; they brought back the idea, and soon care of the sick in special institutions became the concern of the holy orders. Hospitals became established in Italy and France and in other countries. This principle of the Church sponsoring and running hospitals became one of the important activities of the Catholic Church and remains so to the present day. As the Protestant Churches grew in importance they, too, considered hospital work one of their important functions, especially in this country. Later, as concern for one's fellow man became a recognized function of the state, it became one of the elements in the formation of the large municipal and university hospitals which have developed during the last two centuries; however, in these, altruism does not hold the important place which it maintains in the Church-sponsored hospitals.

Naturally the doctors were admitted to care for the patients in the hospitals, but irrespective of their zeal for research, teaching, or personal gain, it has always been understood that they worked in these hospitals primarily for the relief of the suffering of their patients "The patient comes first" is an oft-repeated principle It is also understood that sisters of the nursing orders and nurses enter their work there primarily as a humanitarian function Indirectly they will, of course, benefit the patients by supporting such hospital functions which do not immediately appear to be "nursing care," such as teaching and research. However, throughout the development of modern medicine it is important to note how the teaching of Christ has indelibly placed its imprint upon the hospital and the care of the sick.

This influence is now also felt beyond the hospital It is the underlying principle in public health and the activities of the Red Cross. The Red Cross was originally establishe

surgery concerned treatment of injuries, fractures, and dislocations. However, for centuries surgery was done by barber-surgeons who were low on the social scale. (Incidentally, the stripes on the barber poles outside barber shops represent strips of bandages as they were actually exhibited in the old days.) Not until the eighteenth century did the surgeon become "respectable." The father of modern surgery is John Hunter (1728-1793). He was a Scot who in early youth came to London and became assistant to his brother, William



Fig 4—John Hunter (1728-1793) (Courtesy of Benjamin Salzer-Cecilia C. Mettler Collection, Columbia University, New York City; Medichrome, Clay-Adams Co, Inc.)

Hunter, who was already well established. John Hunter was possessed of indefatigable energy and insatiable industry. His interest covered the whole field of nature, and he had at his estate at Earl's Court outside of London a veritable menagerie of strange animals However, his greatest contribution was in the field of surgery, which he greatly advanced He had a very large practice, and it has been stated that he was to medicine what Samuel Johnson was to letters. He had a

"Grosse Charitee" in Berlin, and the "Allgemeines Krankenhaus" in Vienna came into being. These were products of industrialism. The doctors who were called in to staff these hospitals found them ideally suited for teaching and for mass study of patients. In time the more important ones became attached to medical schools and the chief physicians became the professors at the universities. This has been the development also in this country. Often the staff consisted, in part or entirely, of doctors who were in practice in town but who gave of their time to care for the indigent and to teach the students. This was especially the case in England and in this country. However, in recent years the load of teaching and the other duties of the hospital physicians have become so great that the professors to an increasing extent have become employed full time; most of the great medical schools in this country now have a staff which is part full time and, in part, part time. Some others maintain the principle of entirely part-time teachers. It is believed that these are in more immediate contact with the actual problems of the care of patients.

As medical research steadily consumed more time and energy, these "university hospitals" became the natural places for this to develop, and so we see in the modern hospital a balance between practice, teaching, and research Capitalism and industry accumulated great wealth during the nineteenth century; at first this was mostly in the hands of private persons and families, but gradually much of it accrued to corporations, an outgrowth of capitalism It became customary to devote some of this wealth to medical research, and, especially in America, contributions were made either directly or through funds established for the purpose. Recent years have seen a change in this The policy of increasing taxes has greatly hindered or even prevented the accumulation of huge fortunes; money now goes into government treasuries on which falls much of the burden of medical research and education.

Surgery.—Surgery had humble beginnings. In antiquity it was extremely primitive Anatomical knowledge is the basis for surgery, and, as we have seen, that did not develop until the Renaissance. About this time (1573) appeared the first great surgical work, Paré's *Deux Livres de Chirurgie*, profusely illustrated. Paré had been an army surgeon and in

but it has never been as safe as ether and is now almost abandoned. Recent years have seen the final great advances in "anesthesiology." Many new drugs and their modifications have been introduced, especially barbiturates, and now surgical anesthesia is in most cases both comfortable and safe.



Fig. 5.—Lord Lister (1827-1912). (From Jensen History and Trends of Professional Nursing, The C. V. Mosby Co)

A hundred years ago suppuration was common in the operative wound Pus was expected in the normal course of healing; it was called "laudable pus" Serious streptococcal infections of wounds resulted in epidemics of erysipelas with frightful mortality. The same experience obtained in the obstetrical

great elevating influence upon the profession as a whole, and since his time surgeons came to be as highly respected as were physicians. He founded the English School of Surgery which has flourished to our own time. During the first half of the nineteenth century surgery then advanced step by step, surgeons gained in experience and technique, and operations became more and more daring. In 1809, Ephraim McDowell first removed an ovarian tumor. This was done in Danville, Ky., then practically a wilderness. Other advances were made but cannot be mentioned here. However, surgery suffered two great handicaps: operations were painful, for there were no other means of alleviating pain than by giving copious drafts of whiskey or opiates, and most operative wounds became infected. Bacteriology and the process of transmitting infection being unknown, surgeons operated in their old blood- and pus-stained coats, and their hands and instruments moved from patient to patient with nothing but perfunctory cleansing. The necessity for speed to shorten pain precluded the development of the accurate and detailed technique which characterizes modern surgery. The nineteenth century relieved both of these situations.

The use of three important drugs as surgical anesthetics came within a few years of each other. The anesthetic properties of nitrous oxide had been known since 1800, but it was not until 1844 that the dentist Horace Wells had some of his own teeth extracted under this anesthesia. It gradually became used for short operations. Only in relatively recent years has it and other gases been employed for long ones Ether has for almost a century been the most valuable anesthetic and is still extensively used. Its value as a surgical anesthetic was first proved by Crawford W. Long in Jefferson, Ga. This, however, was not widely published until long after ether had been introduced by W. T G Morton, of Boston The "Ether Dome" at the Massachusetts General Hospital still commemorates the first surgical operation performed (1846) under ether· the removal of a tumor from the neck of a young man by John Collins Warren This was successful, and within a few months the use of ether spread over America and Europe. Within a year (1847) J. Y Simpson, of Glasgow, introduced chloroform for the same purpose. Chloroform became widely used in Great Britain, especially in obstetrics,

blood and other tissue fluids, and it was found that by substituting these the chances of survival were greatly increased. The modern blood and plasma bank is a great advance.

The Further Development of Medicine.—With the advancing years of the nineteenth century the center of gravity in medicine slowly shifted from Paris across the Rhine. The universities of Germany and Austria-Hungary were nourished by the general prosperity and growth of those countries, and they developed medical schools which for the remainder of



Fig. 6.—Rudolf Virchow (1821-1902) (Courtesy of Benjamin Salzer-Cecilia C Mettler Collection, Columbia Univerity, New York City, Medichrome, Clay-Adams Co, Inc.)

the century led the world. The great municipal hospitals provided the clinical material for teaching and research. The *universities of Berlin, Munich, and Vienna became well known* to American students. Again, advance in medical knowledge was based upon the study of pathology: Rokitansky (1804-1878), in Vienna, and Rudolf Virchow (1821-1902), in Berlin, were the leaders, especially the latter. Virchow greatly advanced pathological knowledge, specifically of thrombosis,

wards. In fact, it was not unusual for medical students to *pass directly from post-mortem and dissecting rooms to the delivery rooms.* At that time bacteria were not known to carry disease. Curiously enough, the obstetrical and the surgical problems were separately attacked almost twenty years apart. Ignaz Philipp Semmelweiss (1818-1865), in 1847, read a paper before the Vienna Medical Society recommending the use of a solution of calcium chloride as an antiseptic in obstetrical work. *His views were but slowly adopted.* However, in the meantime, a similar reform developed in surgery. Joseph Lister (1827-1912) became professor of surgery in Glasgow in 1860. He was impressed with the ravages wrought by infections in his surgical wards, and after much research *he devised the use of carbolic acid during operations to* sterilize instruments, the operative field, and the surgeon's hands. For a while a spray of carbolic acid was used in the operating rooms until the harmful effect upon the surgeon and his assistants caused it to be discontinued. This so-called antiseptic surgery was eventually replaced with "aseptic" surgery, where instruments were sterilized before use and *kept insulated against all sources of contamination before* and during the operations. Everything which possibly could come *into contact with the wound was treated in the same* manner Thus was established the modern surgical aseptic technique The value of this new technique was first demonstrated on a large scale in the Franco-German War of 1870-1871, when the Germans adopted it, while the French proceeded according to the old methods with disastrous results.

This double advance, freedom from pain and freedom from infections, enabled *the surgeons to progress* in a manner hitherto impossible. Operations could be made longer and more delicate, and surgeons could penetrate to parts of the body which before had been inaccessible. At first abdominal surgery became *relatively commonplace, and the last thirty* years have seen the development of neurosurgery and thoracic surgery, including operations on the heart and the big vessels. *The extent to which surgery has advanced was well illustrated* by the achievements of World War II, when relatively few wounded died if they *lived long enough to reach* the hospitals.

An additional reason for this was the improvement in pre- and postoperative care. Many patients suffered from loss of

blood and other tissue fluids, and it was found that by substituting these the chances of survival were greatly increased. The modern blood and plasma bank is a great advance.

The Further Development of Medicine.—With the advancing years of the nineteenth century the center of gravity in medicine slowly shifted from Paris across the Rhine. The universities of Germany and Austria-Hungary were nourished by the general prosperity and growth of those countries, and they developed medical schools which for the remainder of



Fig 6—Rudolf Virchow (1821-1902) (Courtesy of Benjamin Salzer-Cecilia C. Mettler Collection, Columbia University, New York City, Medichrome, Clay-Adams Co, Inc.)

the century led the world The great municipal hospitals provided the clinical material for teaching and research. The universities of Berlin, Munich, and Vienna became well known to American students Again, advance in medical knowledge was based upon the study of pathology: Rokitansky (1804-1878), in Vienna, and Rudolf Virchow (1821-1902), in Berlin, were the leaders, especially the latter. Virchow greatly advanced pathological knowledge, specifically of thrombosis,

and embolism, leukemia, fatty degeneration, and many other subjects. His fundamental contribution, however, was his emphasis on cellular pathology. So far, physicians had learned that disease was due to changes in the tissue fluids (humoral pathology), in the organs, or in the various kinds of tissues. It remained for Virchow to show that the fundamental process



Fig 7—Edward Jenner (1749-1823) Courtesy of Benjamin Salzer-Cecilia C. Mettler Collection, Columbia University, New York City; Medichrome Clay-Adams Co, Inc)

was in the individual cells which made up the tissues or the organs. This brought disease into much more accurate focus. Virchow's teaching underlies all modern pathological teaching, but it did not entirely take into account the changes attributable to changes in chemistry, immunology, or endocrine function The full impact of those sciences came in our own century.

About two hundred years ago it was realized that many diseases were contagious, that they were associated with fever which was thought to be an inherent part of the disease rather than a body defense against it, and it was also understood that many infections would not recur in the same person. From time to time it had been suggested that these diseases were caused by minute organisms invading the body, but such views were not generally entertained.

One of the most dreaded infections was smallpox, which attacked many in youth or in their best years, killed a high percentage, and disfigured many more. The procedure of inoculating persons with material from a smallpox lesion would generally result in a relatively mild attack of the disease with subsequent immunity It was used to some extent, but too often was the inoculated infection severe or even fatal. Milkmaids knew that if they contracted cowpox from the udder of a cow with this disease, they would not catch smallpox Edward Jenner (1749-1823), who practiced in western England, learned of this. Having verified this fact, he became convinced that cowpox would protect against smallpox. In 1796 he inoculated (vaccinated) a boy with pus from a cowpox lesion in a milkmaid, Sarah Nelmes He was subsequently unable to produce smallpox in the boy This was the beginning of "vaccination," which practically put an end to the terrible scourge of smallpox Now smallpox is rare in civilized countries.

This was the first step in the conquest of infectious diseases The next important one was not to follow for many years The microscope had been invented in the seventeenth century. From time to time observers had noted small organisms, and about the middle of the nineteenth century it was appreciated that some of them were associated with certain diseases. However, it remained for Louis Pasteur (1822-1895) to establish the full significance of this principle Pasteur is one of the very greatest men in medicine; fully to appreciate his greatness it is necessary at least to read Vallery-Radot's biography of him His life is characterized by hard work along one single line of endeavor, and it is completely devoted to the highest principles of science and humanity Starting with a problem in fermentation which he found could be prevented by a process which since has been called pasteurization, he

was led to combat silkworm disease, which threatened the silk industry with economic disaster, then chicken cholera, anthrax, and finally hydrophobia. In Pasteur's time hydrophobia was a most dreaded disease in France, and to this day it is fatal once it develops. Pasteur developed a method of immunizing the patient after he has become infected but before the disease develops. If properly carried out, it offers complete protection against hydrophobia. The treatment is called Pasteur treatment, and it is carried out in Pasteur institutes which are now found in all important countries. Like many other great pioneers in science, Pasteur was for many years violently opposed by established, orthodox medicine, especially because he had no medical degree. However, toward the end of his career he was generally recognized, not only by the profession but also by the entire nation of France and the world



Fig 8.--Louis Pasteur (1822-1895) in his laboratory. (Courtesy of The Bettmann Archive, New York City)

At the same time many others made bacteriological discoveries The latter part of the nineteenth century truly became the era of the microscope, and the organisms responsible for many infections were discovered. In 1882, Robert Koch (1843-1910) discovered the tubercle bacillus and became one of the founders of German bacteriology, the year after, 1883, h

discovered the organism which causes cholera. Thus a few decades completely changed the face of medicine. However, the discovery of the causes of diseases did not necessarily mean that they could be cured. It was not always possible to apply to them principles such as those used by Pasteur against hydrophobia. The specific cure for most infections had to wait for many years. For some, such as tuberculosis, it still awaits discovery.

The fight against infections took two aspects: (1) An endeavor was made to develop in the patient immunity to the disease or (2) a search was made for a substance or compound which would kill the invading organism without harming the patient. Both methods had been foreshadowed in the past: Jenner's vaccination was immunization against smallpox, and various methods were developed to convey to the patient either passive or active immunity against other infections. In this manner many were controlled: for instance, diphtheria, tetanus, typhoid, pneumonia. Specific drugs for infections had also been known; for many years Jesuits' bark had been used against malaria; later, the active principle was purified and is now used under the name of quinine. It was also known that salicylic acid and its compounds had a specific effect on rheumatic fever. The search for similar drug effects on other diseases has been the logical outcome of the bacteriological discoveries. Most famous in this field were the researchs of Paul Ehrlich (1854-1915). His contributions were many and important, but his greatest fame rests upon his discovery of "606." It had long been known that arsenical compounds had a beneficial effect on syphilis, but all available drugs of this group were too dangerous for routine use Ehrlich set about finding one which combined high therapeutic with low toxic effect. He systematically tested such compounds one after another. Finally in compound number 606 he believed he had found a cure for syphilis. It was called salvarsan and remained for many years an important drug. However, it, too, was not entirely safe and the search continued. Number 914 proved still more suitable. It was called neosalvarsan and remained the principal drug in the treatment of syphilis until quite recent years. Two other metals, mercury and bismuth, were also effective against syphilis, and by using combinations of all of these it was possible to control syphilis, but the treat-

was led to combat silkworm disease, which threatened the silk industry with economic disaster, then chicken cholera, anthrax, and finally hydrophobia. In Pasteur's time hydrophobia was a most dreaded disease in France, and to this day it is fatal once it develops. Pasteur developed a method of immunizing the patient after he has become infected but before the disease develops. If properly carried out, it offers complete protection against hydrophobia. The treatment is called Pasteur treatment, and it is carried out in Pasteur institutes which are now found in all important countries. Like many other great pioneers in science, Pasteur was for many years violently opposed by established, orthodox medicine, especially because he had no medical degree. However, toward the end of his career he was generally recognized, not only by the profession but also by the entire nation of France and the world



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safe and that they had a spectacular effect upon many infections, not only streptoccal but on others, including some forms of pneumonia. At this time, pneumonia was being treated with fair success with serum, but the sulfa drugs proved far superior and much simpler to use. With great enthusiasm a new science developed within a few years. As is usually the case, it was soon discovered that this treatment had its limitations. When used indiscriminately it had dangerous side effects, and the number of diseases which it would cure, though important, was still limited: Staphylococcal infections, virus infections, tuberculosis, and subacute bacterial endocarditis were resistant to it.

In 1929, an English bacteriologist, Fleming, working in a laboratory in Cambridge, England, noted that on some culture plates the growth of bacteria was suppressed in the area surrounding a mold, *Penicillium notatum.* Fleming realized that the mold produced a substance which he called penicillin and which prevented bacterial growth The value of this observation was not appreciated for many years, but in 1942, Florey and Jennings did research in this field and it was soon discovered that penicillin has valuable therapeutic qualities, combining great bacteriostatic power with almost absolute safety. One drawback was that it was difficult to obtain, and for a long time it was available only in exasperatingly small quantities. Then some of the pharmaceutical manufacturers constructed huge plants, and now penicillin is available in almost unlimited quantities. At the same time a systematic investigation was started into the therapeutic qualities of substances produced by other molds, and a great many have become available. Many of them vary in their effects upon different groups of organisms, but at the present time it appears that even virus infections can be brought under control. This work is still in a stage of rapid development, but it seems possible that within a few years the majority of infections may be brought under control. Most cases of pneumonia respond promptly to "antibiotic" treatment. One of the most dramatic revolutions has been in the treatment of syphilis. A few years ago with the best of treatment it took months and years to cure a patient, and many in whom the disease had become well established never were cured. Now an intensive course of penicillin will cure an early case in a few weeks. Its

ment was long and tedious and often failed because the patients would or could not keep it up.

Nevertheless, Ehrlich's "magic bullet" had shown that it is possible to kill pathogenic bacteria in the human body, and the search continued for other compounds which would kill other germs. From time to time it was announced that such a drug had been found, but always it was found that the concentration which was required in the body was so great as to become dangerous. "Chemotherapy," except in syphilis and malaria, retained a very modest place in the treatment of disease.



Fig 9—Paul Ehrlich (1854-1915). (Courtesy of Benjamin Salzer-Cecilia C Mettler Collection, Columbia University, New York City, Medichrome, Clay-Adams Co, Inc)

Then in 1932, Domagk, working in the German chemical industry and testing a number of drugs for their therapeutic qualities, discovered that sulfanilamide had a remarkable effect upon streptococcal infection. Soon other related drugs were also tested, and the thirties became the decade of the "sulfa drugs." It was found that these could be made almost

to list in detail all that contributed to the knowledge which now places the pituitary gland as the master regulating gland among the endocrines; much of it has been done in recent times, and it now appears that it regulates the function of the thyroid, the adrenals, the gonads, growth, water metabolism and sugar metabolism, and many other functions. Thus a great new field of medicine had opened; to this have now been added new discoveries which may explain the nature of diseases of hitherto obscure origin

Probably the greatest advance occurred within the last few years. A group of workers at the Mayo Clinic in Rochester, Minn., including Dr. P. S. Hench and Dr. E. C. Kendall suggested that rheumatoid arthritis was due to failure of the cortex of the adrenal gland. They succeeded in obtaining extract of this cortex and found that the patients improved. This proved to be the key to many new discoveries. It is now obvious that the suprarenal cortex is concerned with many conditions besides rheumatoid arthritis; for instance, rheumatic fever, the so-called collagen or mesenchymal diseases, probably allergy, sugar metabolism, and many others It has further become clear that these functions are regulated by the anterior lobe of the pituitary gland, and disturbances or removal of this gland influence profoundly the function of the suprarenal cortex Work is at progress all over the country to advance our knowledge in this great new field.

The science of radiation is another important contribution to modern medicine. In 1895, Wilhelm Conrad Roentgen (1845-1923) discovered that when electricity passes through a vacuum tube it gives off certain rays which possess the quality of penetrating some solid substances, but not others, and they give an image on a fluorescent screen or a photographic film The point is that the rays penetrate softer tissue such as lungs, or even muscle, if not too thick, but are stopped by heavy tissues and bone Thus the rays could be used to demonstrate the shape of bones and the nature of fractures. Then later it was found that the heart and other solid masses in the chest could be outlined against the lungs Hollow organs, such as the stomach, could be filled with opaque material (salts of barium) and their outlines studied. On these principles developed the science of x-ray diagnosis. It was, however, soon found that these "x-rays" had other effects on tissues. They were power-

value in more advanced cases is still uncertain. Not only are these "antibiotics" curative, but they are valuable also in the prevention of infections; for instance, they will prevent bacteriemias in dental work, pneumonia following cerebral hemorrhage, or postoperative infections. They proved of the greatest value in World War II. The period from about 1860, when antiseptic surgery was established and the relationship of microorganisms to disease was appreciated, to 1950, when the principle of antibiotic therapy was thoroughly established, forms an era of medical progress outstanding in dramatic interest and completed achievement.

It is possible that the present time marks the beginning of another similar development in endocrinology. It had long been known that certain glands profoundly influence bodily functions; the effect of castration had long been known both in husbandry and in the eunuchs in the Orient. Graves had recognized the relation between the thyroid gland and the changes of hyperthyroidism, and Addison knew that disease of the suprarenal glands had resulted in profound constitutional changes which ended in death. However, the full appreciation that certain organs in the body secreted substances into the body fluids which acted as regulators of all its functions is due to Claude Bernard (1813-1878). Apart from his many individual contributions to physiology, Bernard is responsible for the concept of the "milieu intérieur" of the body; that is, the body attempts, through the functions of its various organs, to maintain a beneficial or favorable state of its fluids and thus of its cells Thus was foreshadowed many discoveries of the next century and probably many yet to come. It became clear that many organs of which the function had been obscure played a vital part of body economy. The work of Brown-Séquard, supplementing the observations of Addison, established the adrenal gland as being of vital importance. Minkowski and others showed the part played by the pancreas in diabetes Opie showed that the islands of Langerhans were the organs which secreted the regulating substance. Finally, Banting and Best isolated insulin in 1921. The work of Schiff and of Sir Victor Horsley proved the relationship of the thyroid gland to the clinical conditions now recognized as hyperthyroidism and hypothyroidism, and in 1914, Kendall isolated the active substance thyroxin. Space does not permit

Almost all doctors were trained through apprenticeship and, if they could afford it, went to Europe for further training. Some became prominent as autodidacts. Most outstanding in the early nineteenth century was William Beaumont (1785-1853), an Army surgeon of the Indian Wars. In 1822 he was called upon to treat an Indian scout, Alexis St. Martin, for a gunshot wound in the abdomen. The man recovered but was left with a permanent fistula from his stomach. Beaumont made full use of his opportunities to study gastric function and wrote his classical *Observations and Experiments on the Gastric Juice and the Physiology of Digestion* in 1833. He later was transferred to St. Louis where he resigned from the Army and turned to private practice in that city for the rest of his life.

Daniel Drake (1785-1852), a contemporary of Beaumont's, was trained as an apprentice to William Goforth in Cincinnati, after which he received some formal training in Philadelphia. He was a born teacher but apt to disagree with his colleagues, so he spent his life between various newly established schools in Kentucky and Ohio. Besides being an outstanding teacher he left several literary masterpieces, the most important one being his *Diseases of the Interior Valley of North America*, which contains a comprehensive description of the Mississippi valley.

It may also be remembered that both nitrous oxide and ether anesthesia originated in this country

It is not possible to mention many of the great names in American medicine during the latter part of the nineteenth century. On the whole, however, it developed slowly. The medical centers were relatively small and unimportant, and much postgraduate teaching had to be obtained in Europe where the great schools flourished in Vienna and Berlin However, with the growing prosperity of the country, medical schools grew, and from being small private affairs run principally for profit and graduating their students after a few semesters, the more important ones became associated with universities and developed ever-improving standards.

It was at this period that William Osler (1849-1919) became the leaven that stimulated American medicine to tremendous growth. Osler had been born near Toronto and had held teaching positions in Montreal when he was called to Phil-

ful irritants which promoted tissue growth and even malignant changes. Many of the early workers who exposed their hands to the rays developed skin cancers from which they died. In proper dosage the rays would kill tissue, particularly if these were active and growing: thus, x-rays can be used to suppress the function of the thyroid gland or the gonads and also the growth of many malignant growths. Consequently x-rays have become a most valuable means of treatment.

In 1898 the Curies discovered that the newly discovered substance radium also gave off rays which soon were found to have a similar effect upon tissues. When radium was placed in or near certain tumors, the tumor tissue was found to wilt away and sometimes to disappear altogether. Workers all over the world cooperated in developing this technique, and x-ray and radium radiation combined with surgery have greatly advanced the treatment of malignant tumors It was then found that radioactivity could be conveyed to other substances, such as phosphorus or iodine, which could be injected into the blood stream and either affect pathological cells which were present there (leukemia) or show affinity for certain organs (iodine for the thyroid gland) This field also is in a stage of rapid development at the present time

These are just some of the high spots of the development of modern medicine. Like other technical sciences, it is at present moving forward under a tremendous impetus and, barring war, it is likely to move even closer to its goal of rendering the human race safe from disease

American Medicine. -America has played an accelerating part in the development of medicine. For about the first century and a half the colonists had a hard time establishing themselves on this continent, and they had not yet created the wealth necessary to sustain a prosperous medical profession. However, about the time of the revolution there were a number of doctors of high repute, many of whom took a prominent part in the political proceedings. Benjamin Rush, one of Philadelphia's leading citizens and physicians, was one of the signers of the Declaration of Independence Benjamin Franklin was one of the organizers of Pennsylvania General Hospital which did so much to further the medical development of Philadelphia. However, the lack of well-organized medical schools, such as were found in Europe, was a great handicap.

The American Medical Association was formed in 1848. It became the most influential medical body in the country, and in about 1910 it undertook a reform of the medical educational system of the country. The result has been elimination of the poor schools and improved standards of the good ones. At the same time the growing prosperity of the country facilitated the construction of magnificent hospitals and medical schools which formed the physical basis for the progress which followed. During the twenties and the thirties American medicine forged ahead of European medicine. Europe was now impoverished and exsanguinated by a great war and had neither the money nor the energy to match the pace set by the United States. This development was accentuated during the second World War when efforts in Europe were directed toward destruction, while American medicine continued to grow, and at an accelerated pace after the Armistice. While the nineteenth century saw very few fundamental medical discoveries originate in this country, the last fifty years have seen them here in increasing numbers. In 1922 insulin revolutionized the treatment of diabetes (insulin was discovered in Canada); a few years later pernicious anemia was conquered in Boston. While chemotherapy and antibiotics did not originate in America, they were enthusiastically embraced and developed here, and the new field of treatment with cortical hormones is an American contribution. Thus at the present time the world leadership in medicine rests securely in American hands.

Labor and the Welfare State.—As American capitalism grew during the nineteenth century it tended to become arrogant and unscrupulous. It exploited labor and would have dominated the country if it had not been opposed The opposition came principally from labor which slowly but surely became organized into unions. Gradually the unions grew in power until they now have great political, economic, and social influence. The union leaders sought security for their members against unemployment, old age, and sickness Security against ill health can best be obtained by sharing the risk under some sort of insurance scheme. In the beginning these schemes were private, organized by insurance companies or sponsored through companies or unions, but gradually the pressure grew upon the government to assume the role of protector of the

adelphia and a few years later to the newly organized medical school at Johns Hopkins University in Baltimore. Here he developed the outstanding medical service in the country, and his house officers and associates were sought after for important teaching positions throughout the country. His clinical acumen was extraordinary, and he had a tremendously stimu-



Fig. 10.—Sir William Osler (1849-1919) (From Jensen History and Trends of Professional Nursing.)

lating effect upon all of those around him He also participated in the furthering of many medical organizations and wrote his *Principles and Practice of Medicine* (1892) which has remained one of the leading medical textbooks. In 1904 he was called to become Regius Professor at Oxford, but his influence in American medicine continued to his death.

and disease and all of those involved therein. Government health service was made practically universal in England after World War II. It is not working satisfactorily at this time, and the doctors are threatening to strike unless it is reorganized. In this country the struggle has been fierce; at the present time most of the doctors and a very considerable part of the population believe that they can be better served by protection through private associations and insurance companies; the labor unions and powerful forces within the government feel that the more government-sponsored health insurance prevails, the better will the public be served. The fact remains that under the prevailing system, American medicine has achieved undisputed international leadership, both as regards the care extended to the individual patient and medical education and research. Any new system must, at least, equal those standards.

STUDY QUESTIONS—UNIT I

1. Trace the development of modern medicine and show how it was interrelated with Western culture.
2. Compare *speculative superstition* and *simple observation* and describe the fundamental philosophy in each.
3. Discuss two developments influencing medicine during the Renaissance.
4. Sketch briefly outstanding medical discoveries and trends during the seventeenth and eighteenth centuries
5. What have been some of the lasting contributions of Christianity to medicine?
6. How have industrialism and capitalism affected medicine?
7. What two discoveries in the nineteenth century revolutionized the practice of surgery?
8. Discuss two important aspects of the control and conquest of infections.
9. Describe and explain the increasing influence of the United States on modern medicine
10. Describe briefly the contribution of each of the following to medical science: Hippocrates, Vesalius, Harvey, Sydenham, Boerhaave, Morgagni, Linnaeus, Bichat, Louis, Dunant, Paré, John Hunter, McDowell, Crawford W. Long, W T. G. Morton, J. W. Simpson, Semmelweiss, Oliver W. Holmes, Lord Lister, Virchow, Jenner, Pasteur, Koch, Ehr-

sick. More and more health problems have been considered the concern of the state. For many years it was readily and generally accepted that the state should protect its citizens against epidemics brought into the country from abroad, so a quarantine service was established. It also became clear that the care of the mentally ill was a matter of public concern, and hospitals for the mentally ill were established. To this was added the care of the indigent and the treatment of patients with long-lasting diseases, such as tuberculosis. As time has passed, more and more provinces of medicine have become the responsibility of the state. Quarantine service was extended to embrace the prevention of disease generally and the protection of the public, and so public health service developed. It is concerned with the purity of drinking water, regulations of standards for marketing and preparation of food, working conditions, protection against epidemics, prenatal and infant care, etc. Thus public service has steadily grown either by developing new fields or by taking over those previously the concern of the private citizen. Changing social and economic conditions bring about much of this. As heavy tax laws prevent the accumulations of private fortunes, the generous gifts of the past to medical research are becoming more difficult to obtain, and research looks to the state for its support Many of these developments are inevitable results of our general social and economic evolution, and most of them have been accepted with relatively little controversy. Real difference of opinion has risen over the actual care of sick people.

Bismarck in Germany about 1870 and Lloyd George in England in 1910 inaugurated government-sponsored health-schemes, whereby physicians, compensated by the government, would look after the health of certain groups of "insured" people, generally in a low-income class Other countries inaugurated similar schemes, and the coverage included an increasing part of the population Those opposed to state interference and "socialism" objected, stating that this development would destroy the intimate doctor-patient relationship, lower the quality of medical service, and let many people overwork the doctors by seeking aid unnecessarily This struggle has raged continuously and is still on. The outcome will profoundly influence the whole matter of care of health

UNIT II

THE CAUSE OF DISEASE

In order to understand the material presented here, general review of anatomy, physiology, and chemistry is necessary as the student studies the causes of disease in the body. A review of nutrition in general as already mastered in that special course will clarify the discussion of nutritional disturbances. Reference to books on bacteriology and materia medica will be necessary for the full understanding of Chapters 6, 7, and 11.

CHAPTER 2

INTRODUCTION AND CLASSIFICATION

Definitions.—Disease is any condition arising in the body which interferes with its normal, physiological function As a matter of simple classification, disease may be:

1 *Congenital,* the patient is born with it (harelip)
2. *Traumatic,* or due to external injury (broken leg)
3. *Infectious,* due to invasion with microorganisms (pneumonia)
4. *Parasitic,* due to invasion with more highly organized creatures such as worms which derive their nutrition from the host they have invaded
5. *Endocrine,* due to disturbance of the function of any of the glands with internal secretion (exophthalmic goiter)
6 *Neoplastic,* due to overgrowth of normal or abnormal cells in the body (cancer)

lich, Domagk, Fleming, Florey, Claude Bernard, Hench, Kendall, Röentgen, the Curies, Beaumont, William Osler, Banting.

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CHAPTER 3

CONGENITAL DISEASES

Introduction.—Some children are born diseased. There are two groups of congenital diseases: malformations and diseases contracted in utero.

It is an everlasting wonder that the fertilized ovum contains within itself the power to subdivide into cells which soon become able to differentiate themselves as to structure and function so that the resulting individual reflects not only species and race, but also some of the individual traits of its parents. Some of these developments are extremely intricate, such as the development of the heart with its chambers and valves from a simple vascular tube. It is well known how this development passes through stages characterized by the development of temporary organs, such as the brachial clefts or the thyroglossal duct. Congenital lesions may arise either from failure of some of these developments to occur or from persistence of structures which should disappear in the normal course of development.

The possible malformations are innumerable, and this is not the place for their detailed consideration. Here shall be considered but a few illustrative examples.

The two sides of the face may fail to come together in perfect symmetry, especially the upper lip, which may remain separated in its original two parts (harelip). This defect may extend backward into the palate which remains cleft. The perfect balance of the muscles governing the eyes may fail with the result that some muscle pulls the eye out of line (strabismus, squint)

The Central Nervous System.—The central nervous system is particularly prone to maldevelopments. The brain itself may fail to develop (microcephaly), with resultant imperfect

7. *Nutritional*, due to too much or too little food or to an improper amount of some constituent of the food, such as one of the vitamins
8. *Degenerative*, due to change in certain groups of cells in the body to the extent of interference with their function (arteriosclerosis)
9. *Functional*, a condition in which some function is disturbed without demonstrable organic cause
10. *Due to physical agents*, such as heat, cold, or change in barometric pressure
11. *Toxic*, due to the introduction into the body of some substance in an amount with which the body defenses cannot cope

Like most other biological classifications, such an arrangement is very crude and serves only as a most elementary orientation into the causes of diseases, for there are many conditions which do not fall into any one of the above-mentioned groups and others which fall into more than one group. Rheumatic fever, for instance, behaves like an infection and yet it has never been possible to identify a given microorganism as the cause. Exophthalmic goiter is both a neoplasm of the thyroid gland and an endocrine disorder.

Another reason why such a classification "according to cause" is unsatisfactory is that it often does not really explain the "cause" of the disease, for often persons exposed to the same cause do not develop the disease; for instance, many are invaded by the tubercle bacillus, but few develop tuberculosis. We are continuously asking ourselves and our doctors what is the cause of this or that disease, but too often the answer is an admission of ignorance or an assumption of some unproved, apparent factor. This may be misleading, for the real importance of knowing the cause of a disease is that this knowledge is the first necessary step toward its cure and prevention. It may, therefore, be well to approach the study of disease from a most fundamental point of view and try to learn as much as possible about the factors which we at the present time know or suspect to be instrumental in disturbing the normal functioning of the human body. To some extent such a study will conform to the orthodox classification just given, but it will not be bound to it.

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mental development. A peculiar variety is the Mongolian idiot, in whom defective mental power is associated with slanting eyes, protruding tongue, and often other congenital defects. Sometimes the eyes fail to develop and a person may be born blind. An excess of cerebrospinal fluid may cause excessive extension of the brain. This happens while the skull is still soft and pliable, and the calvarium may therefore

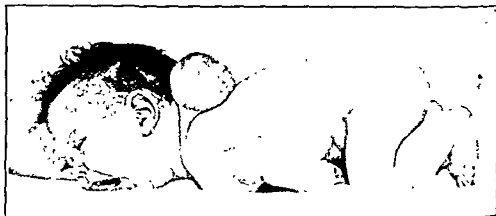


Fig 11.—Spine bifida with meningocele in the cervical region. (From Meakins Practice of Medicine, The C. V. Mosby Co.)

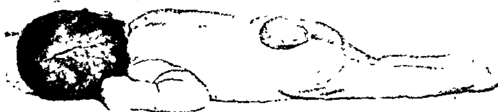


Fig. 12 —Spina bifida with meningocele in the lumbosacral region (From Meakins Practice of Medicine.)

assume a very large size The spinal canal may fail to close, especially in its lower part, and the contents may form a hernia or cyst which can be seen on the back. This condition is called spina bifida There are many other possible defects of the central nervous system but most of them are rare

The Cardiovascular System.—Some of the most important congenital defects occur in the cardiovascular system, espe-

cially the heart itself. It may be placed in the right side of the chest (dextrocardia). This may occur as an isolated finding or as part of transposition of the other viscera (situs inversus). The normal four chambers may fail to develop—there may be only two (cor biloculare) or three (cor triloculare). The adequate number of chambers may develop but fail to be separated into right and left chambers. There may be defect of the interauricular septum (for instance, patent foramen ovale) or of the interventricular septum (foramen



Fig 13.—Congenital heart disease (Tetralogy of Fallot) showing clubbing of fingers and cyanosis. (Courtesy of Dr Rosa Lee Nemir, New York University, Post-Graduate Medical School, Medichrome, Clay-Adams Co, Inc)

interventriculare, Roger's disease). Ductus arteriosus, between the pulmonary artery and the aorta, may remain patent. Various obstructions may develop to the blood stream, especially near the sites of the cardiac valves (congenital pulmonic stenosis, congenital aortic stenosis) or in the aorta (aortic coarctation) Many of these defects may occur in combinations which may create difficulties in diagnosis. A very important congenital condition is Fallot's tetralogy which is a combination of pulmonic stenosis, interventricular septum defect, right ventricular hypertrophy, and displacement of the aorta to the right This is one of the most common causes of "blue bies" The clinical importance of congenital heart condi-

tions have greatly increased in recent years since many of them have become amenable to surgical treatment.

The Gastrointestinal Tract.—The gastrointestinal tract is subject to a number of congenital defects; these are particularly outpouchings from the lumen (diverticula) and narrowings (strictures). Diverticula will occur from the esophagus and from the stomach. Sometimes the diaphragm becomes an imperfect separation between the thorax and the abdomen and a hernia will pass through it (hiatus hernia). These often remain without symptoms until much later in life. "Meckel's" diverticulum arises from the lower part of the small intestine The colon may be congenitally dilated (megacolon). The strictures occur mostly where sphincters are naturally found—at the entrance of the esophagus into the stomach, at the pylorus, and in the lower rectum; the anus may be more or less imperforate (atresia ani).

The Respiratory Tract.—The respiratory tract has relatively unimportant congenital defects. The lungs may have accessory lobes, and there may be congenital cysts of the lungs. These may later become infected.

The Genitourinary System.—The genitourinary system may show congenital absence of one kidney, or the kidneys may be joined at the lower poles (horseshoe kidney). The kidney may have double ureters, and the bladder may have diverticuli which may assume clinical importance, for stones may develop in them. There may also be exstrophy of the bladder, whereby it remains a sac opening into the anterior abdominal wall. The testes may fail to descend into the scrotum and remain in the abdomen or the inguinal canal (undescended testicle), and in the male the urethra may open on the undersurface of the penis instead of the tip (hypospadias). The female genitalia are subject to many congenital malformations which are described in detail in gynecological texts Some of the more important ones are bicornuate or double uterus, double or strictured vagina, and imperforate hymen. These may all in various ways interfere with childbearing.

Sexual Abnormalities.—Finally, there is the large group of sexual abnormalities with over- or underdevelopment of the various organs or even hermaphroditism. True hermaphroditism is exceedingly rare in man. In this condition the indi-

vidual has one testis and one ovary. Most cases are of so-called pseudohermaphroditism: These patients are genetically of one sex but have the external sexual characteristics resembling the other.

Miscellaneous Congenital Defects.—The extremities may also show congenital defects: The hip may be dislocated, or the bones of the foot may be poorly developed (clubfoot). There may be supernumerary toes or fingers or some may be absent; even a whole extremity may be missing.

The skin is subject to congenital defects, pigmentation may be entirely lacking not only from skin and hair, but from the iris as well, and the pupils appear pink. Persons with such a defect are called albinos. There may also be extensive pigmentation especially in circumscribed areas (nevi). Nevi may also be vascular and consist of dilated blood vessels under the surface. Skin may extend between fingers and toes (webbing), or there may be overgrowth of the horny elements, (ichthyosis —literally, fish skin). In these patients the skin is dry and scaly, and there is little activity of the glands which normally keep it smooth and moist. Finally, it may be unusually elastic; such patients frequently find a living as India rubber men in circuses.

There are many more congenital malformations of the body, but these must serve as examples The other group of congenital diseases, those acquired as such in utero, are not nearly so numerous

Children may acquire infectious diseases before they are born. This is especially important in the case of syphilis. Other infections are rarely acquired before birth In fact, the fetus and newborn child are immune to most infections.

Tumors, especially teratomata, may develop in the fetus and be present at birth.

Birth injuries constitute another group of congenital disorders. They chiefly affect the nervous system and may result from intracranial injury to the fetus during birth and from stretching and pulling upon peripheral nerves as extremities become stretched or bent.

Thus it will be seen that congenital diseases comprise some which may also be considered endocrine (hermaphrodites), infectious, neoplastic, and traumatic

When describing some diseases as being congenital we are not really giving the cause but merely describing one feature of their etiology. There is no satisfactory explanation for congenital malformations. Some of them, such as polydactylism, tend to run in families and must, therefore, be ascribed to some abnormality of the genes. Some congenital heart disease has been associated with an infection (for example, German measles) in the mother during pregnancy, but this is not much of an explanation. Such explanations as injury or mental shock to the mother during pregnancy have not been substantiated. So, in general, it may be observed that the cause of congenital malformations is unknown, while some infections, tumors, and injuries may be considered congenital in the sense that they occur before and during birth, but in these the "congenital" feature is not the cause.

CHAPTER 4

THE DEFENSES OF THE BODY

Introduction.—Mammals, including man, differ from almost all other creatures in their manner of procreation. During the first part of its life the mammalian offspring remains in its mother's womb protected against all stress and injury and without concern about its nourishment However, from the moment of its birth it finds itself in a hostile environment It must live in temperatures below or above those which must be maintained in its own body and it must create a balance between the food and water which it absorbs and that which it excretes In intrauterine life this was facilitated by its mother Now it must balance the different constituents of food, salt, and water. Above all, the hydrogen ion balance and the fluid contents must be maintained within certain limits, and so must the concentrations of all sorts of other chemicals, such as glucose, protein breakdown and waste products, etc. It must also create defenses against microbic invaders which will destroy it unless they are checked, and its tissues must maintain the ability to heal when injured. This entire system of checks and balances to keep the body forces within physiological limits is called "homeostasis" It is the essential process of maintaining life against all destructive forces.

It still remains a mystery how this is accomplished Certainly this mechanism varies greatly with the individual: Several persons may be exposed to the same infectious organism and only some develop the infection and some may succumb to a strain which does not prove fatal to others; obviously some are stronger than others who have developed in the same environment. Also those who fall victims to damaging agents may respond in different ways: Among those who develop tuberculosis some will develop lesions in the lungs, some in the

joints, some in the kidneys or other organs. In some the infection will be slow and lingering and in others, fulminating.

STEROIDS

Introduction.—The course of contemporary medical research indicates that the steroids are of fundamental significance in health and disease. This has long been appreciated by those concerned with the scientific aspects of medicine, but it was not thought that knowledge of the steroids was of much practical value. Therefore, little is said about them in nursing texts Now it is being realized that steroids are concerned with certain fundamental principles, knowledge of which is necessary for the understanding of some of the most important diseases with which nurses are concerned.

In order to understand this discussion, the student must know, if necessary, review, the following facts of organic chemistry: the structure of the aliphatic chain, including acetates, acetone, long-chained fatty acids and sugars, the benzol ring, its combinations, the matters of esters, double bonds, and side chains This information will be found in any elementary text on organic chemistry.

Steroids are structures derived from phenanthrene. Phenanthrene is a component of coal tar. It consists of three benzol rings and a pyrrol ring. This structure is basic and is found in all the substances here under consideration

Cholesterol.—A discussion of steroids in the human economy may well start with cholesterol. It is found extensively in the body and is the substance from which some of the others are formed. Cholesterol is found in the blood stream, normally 150 to 180 mg per 100 cc of plasma Some of it is free, but most of it is in the form of esters of long-chained fatty acids. The body has two important sources of cholesterol; some of it is derived from the food (eggs, milk, butter, and other animal fats), and some of it is made by the liver from acetate, acetone, and water.

From the blood, cholesterol gets into various tissues in the body. However, the manner and degree in which tissues receive cholesterol vary greatly. Cholesterol is absorbed by the wall of the blood vessels, especially the arteries. When it arrives in the wall of the arteries of young persons, it is

promptly removed by certain cells which absorb it and remove it. With increasing age, the body becomes less efficient at removal of cholesterol from the vascular wall. When cholesterol remains there, it becomes an irritant and causes changes known as atheroscelerosis. When these changes become more advanced, calcium is deposited in the lesions and the condition is now called arteriosclerosis. Atherosclerosis and arteriosclerosis are essential processes in degenerative heart disease (Chapter 8).

Cholesterol is an important constituent of bile. Many gallstones are made of cholesterol which has been precipitated from bile. Some of the cholesterol in the bile is changed into cholic acid. From being an unimportant part of bile, cholic acid attained great importance when it became the substance from which cortisone is made.

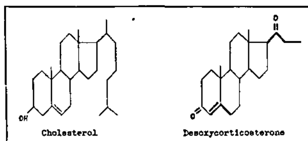


Fig. 14—Cholesterol and Desoxycorticosterone (From Jensen. J. Missouri M. A., January, 1951.)

Cholesterol is also an important constituent of the central nervous system, but there it remains permanently and does not partake in the various processes with which this chapter is concerned.

Cholesterol is the parent substance of dehydrocholesterol, which resembles it closely. When dehydrocholesterol is brought to the surface layers of the parts of the skin which are exposed to the ultraviolet rays of the sun, it is changed into vitamin D_3. This vitamin (Chapter 5) is essential for the absorption of calcium and phosphorus from the intestinal contents and for their deposition in bone.

Some of the glands with internal secretion retain cholesterol and transform it into substances which are of the greatest importance in the body economy.

Sex Hormones.—The sex hormones fall into three groups: the female sex hormones are the (1) estrogens and (2) progesterone and the male sex hormones are (3) androgens

Of the estrogens, estradiol is the most potent found in nature. It is probably the one which is secreted by the ovary. Others, closely related, are excreted by the testes, the placenta, and the suprarenal cortex. These compounds are responsible for ovulation, menstruation, and development of the secondary sex characteristics. It is probable that cholesterol is the substance from which estrogens are formed, though this point is not yet proved.

Progesterone is the hormone of corpus luteum. It is necessary for the implantation of the fertilized ovum in the uterine wall and for the continued development of the pregnancy. Its deficiency may be a factor in "habitual abortion." It also has to do with changes which prepare the mammary gland for lactation. During pregnancy the body forms large quantities of progesterone from cholesterol. Much of it comes from the placenta which thus becomes an important endocrine organ The rest comes from the ovary.

Of the androgens, testosterone is most important. It is secreted principally by Leydig's cells in the testes Probably it is formed from cholesterol, though this has not been proved. Androgens are produced also by the suprarenal cortex, this function becomes important in certain endocrine disturbances

The gonads and the suprarenal cortex have common embryological origin.

The Corticosterones.—The suprarenal glands consist of two entirely different tissues, the medulla and the cortex. The cortex is an important endocrine organ. In it cholesterol is found, with vitamin C, in great concentration; it is the substance from which some and perhaps all of the "corticosterones" are formed. The "corticosterones" are simply the steroids which are formed in the cortex There are at least twenty-eight of them, but only a few are of known clinical importance. They fall into three groups: the mineralocorticoids, the glucocorticoids, and sex hormones.

As will be seen from Fig. 15, they are, chemically, all very similar. The significant changes will be noted.

Of the mineralocorticoids, desoxycorticosterone is most important. It has no oxygen in position 11. It is concerned with

the retention of water and sodium and with the excretion of potassium and also with fluid and electrolyte balance between the cells of the body and the spaces in which they live. It, or some closely related substances, has some effect upon the wall of blood vessels, for it may cause vasoconstriction of the efferent arteriole of glomeruli in the kidney, and it may also cause constriction of other small blood vessels if they have become sensitized to its action. This may be an important factor in the development of some forms of hypertension.

The glucocorticoids all have oxygen in position 11, either in the form of an oxygen atom which is tied with a double bond

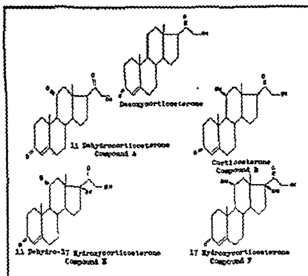


Fig 15—Corticosteroids (From Jensen, J. Missouri M A., January, 1951)

to the carbon (cortisone) or in the form of a hydroxyl group (compound F). They have a large number of functions which it is difficult to differentiate. They all have to do with the body's metabolism of organic substances and its defenses against stress and injury and may be mobilized with great rapidity.

The regulations of carbohydrate, fat, and protein are all under the control of the corticoids.

Carbohydrate is obtained from carbohydrates in the food and from the breakdown of nitrogens. It is made available to

the peripheral tissues where it is metabolized and to the liver where it is stored. Insulin is produced by the beta cells of the pancreas and is instrumental in metabolizing of carbohydrate. There is evidence that the corticoids affect many of these processes, sometimes in a manner antagonistic to insulin: it is possible that they suppress the formation of insulin, they inhibit the peripheral metabolism of carbohydrate, and they accelerate both the formation of glucose from proteins and its storage, as glycogen, in the liver. The total effect of all these functions is to elevate the concentration of glucose in the blood; sometimes glycosuria results. Because these are characteristic of diabetes, the effect is called diabetogenic.

The glucocorticoids cause a general breakdown of proteins, including the nucleoproteins which contain uric acid. They are followed by an increased excretion of both nitrogen and uric acid in the urine.

The effect on the metabolism of fat is less well known, but there is some evidence that the glucocorticoids encourage the formation and storage of both neutral fat and cholesterol.

The corticoids have some effects upon the blood-forming organs which are poorly understood but which in some way have to do with the defenses of the body against certain forms of injury. They may be considered under three headings.

The corticoids will dissolve lymphocytes and lymphocytic tissues such as lymphosarcoma. They, therefore, cause a lowering of circulating lymphocytes in the blood and they may, temporarily, cause a diminution of lymphosarcomatous tumors The lymphocytes play an important part in the development of immunological processes (p. 84). It is, therefore, thought that corticoids may possibly play a part in the development of immunity or the defenses against infection

The corticoids will cause a diminution, or disappearance, of the eosinophile cells of the blood. Increase of eosinophiles is characteristic of allergic reactions (p. 90). The glucocorticoids will relieve the allergic symptoms as they cause disappearance of the eosinophile cells.

The body responds to certain forms of stress or injury (or possibly endocrine deficiency) by swelling of the basic connective tissue substance, sometimes with resultant deformity which may be painful. Such lesions are seen around the joints in acute rheumatic fever (p. 181) and in rheumatoid arthritis

(p. 181). Cortisone and compound F have a most dramatic effect upon these lesions. It causes a prompt relief from pain and disappearance of the swelling when it is given in doses of a few hundred milligrams. None of the other corticoids appear to have this effect. Cortisone does not cure these rheumatic diseases for the symptoms recur when it is stopped.

The General Adaptation Syndrome.—However, in spite of all these differences, a certain fundamental law can be discerned in the response of the body to almost all kinds of injury. It has by Selye been termed the general adaptation syndrome. It consists of four phases: (1) shock, (2) countershock, (3) stage of resistance, and (4) stage of exhaustion. The shock and countershock phases together are called the alarm reaction. Depending upon the nature of the injury, these phases may be modified absolutely and in relation to each other. If the injury is overwhelming, the shock may be profound and even fatal. The countershock is the immediate mobilization of the defenses against the injury. Its efficiency is determined by the balance between the force of the injury and the forces which the body can mobilize to overcome it. If the injury can be contained but not overcome, there ensues a stage of balanced "warfare" called the stage of resistance It has been postulated that each individual is endowed with a certain finite power of resistance, and if the struggle continues long enough this power will become exhausted and the final "stage of exhaustion" develops It ends fatally unless checked.

The features which, according to Selye, are essential in the four stages are:

The characteristic features of shock are lowering of the body temperature and of the blood pressure, depression of the nervous system, increased permeability of the capillary wall and of cell membranes, generalized tissue breakdown with lowering of the blood sugar These are the principal changes but there are others.

During countershock many of these changes are reversed and are indications of mobilization of body defenses· temperature and blood pressure increase, often above normal, the nervous system becomes hyperactive, and there is a shift of tissue fluids with increased diuresis and increase in blood pressure

During the stage of resistance these more violent changes subside and the body develops defenses which specifically will counteract the type of stress to which it is exposed. This is the state which obtains in chronic diseases which are under control or in persons who are under chronic stress which they are able to endure (for example, aviators in active warfare).

The stage of exhaustion is the stage of breakdown of the defenses against the stress. It is, therefore, determined by the kind of stress to which the body is exposed. Clinically this is the stage of final breakdown which is seen in chronic diseases: the crises of Addison's disease, heart failure which fails to respond to treatment, coma resulting from cerebral injury, marked changes in the body chemistry, uremia, diabetic coma, the final collapse in an infection or extensive tissue injury.

All of these stages are readily recognized by any one working in a hospital ward. However, it soon becomes apparent that apart from the more or less general features common to all cases, there are modifications which vary with almost every case. It has been indicated how the nature of the stress or injury will determine the kind of response which will be evoked: A crushed limb, a dose of poison, overfunction of the thyroid gland, hypertension, emotional stress will all, by virtue of their different natures, provoke different reactions But the state of the body will be another determining factor: If it has been previously weakened by cold, starvation, and exposure, it will not respond as well as if it has been prepared by rest or training. Also, the principle of *locus minoris resistentiae* has long been recognized; that is, in each person certain organs or parts of the body show less resistance to a given stress than do others. Even lay persons recognize some individuals as having "weak kidneys" or a "weak stomach," etc.

Thus the reaction, or "clinical picture," resulting from any given stress to which the body is submitted is determined by (1) the nature of the stress or injury, (2) its force, (3) the nature of the body which is attacked, and (4) its general state of health when attacked.

So far this discussion has been held in the most general terms, and the "defenses" of the body have been considered rather vaguely. This has been the general state of information until recently, but within the last few years knowledge of these defenses has become much more specific and concise, and we

can describe a specific defense mechanism which apparently is concerned, nonspecifically, in all types of stress and injury. Thus it is clear that when the homeostasis of the body is disturbed by whatever cause, a certain fundamental mechanism is set in motion to protect it The mediator between the "stressor" and the defense mechanism is unknown, but apparently, somehow, the nervous system is aroused. It is the more fundamental, primitive part of the nervous system which is first affected—the sympathetic nervous system and the thalamic nuclei in the brain.

The Adrenal and Pituitary Hormones.—Stimulation of the sympathetic nervous system results in the liberation of "adrenergic" substances from the medulla of the suprarenal gland and from the sympathetic nerve endings. "Adrenergic" means that the substance has qualities similar to those of adrenalin and related substances It may be remembered that the suprarenal gland consists of two parts, a cortex and a medulla; the medulla is under the control of the sympathetic nervous system and, when stimulated, secretes adrenalin and nor-adrenalin into the blood stream. Adrenalin has a number of functions all of which are aimed at strengthening the body defenses. It has a pronounced effect upon the cardiovascular system: It strengthens the contractions of the heart muscle and increases the rate. The increased force of the heart increases the pulse pressure and thus also the systolic blood pressure. It will also tend to increase the blood pressure by the contraction of some peripheral blood vessels. Adrenalin also increases the blood sugar, thus making more nourishment available to the tissues which are under stress. Most important is the stimulation of the anterior lobe of the pituitary gland to secrete the adrenocorticotrophic hormone (ACTH).

From the thalamic nuclei stimuli reach the pituitary gland. It consists of two parts, an anterior (or glandular) portion and a posterior (or neurogenic) part Both of them have important endocrine functions The posterior pituitary hormones increase the blood pressure and control the excretion of water through the kidney. Their action here is "antidiuretic"; that is, they increase reabsorption of water in the tubules.

The more important part of the pituitary gland is the anterior lobe. It secretes hormones which govern several vital functions Space does not permit a detailed discussion of all

the anterior pituitary hormones, but among them is one (or more) which stimulates the suprarenal cortex. In this function the gland is largely governed by the thalamic centers of the brain and by adrenalin. The suprarenal cortical hormones, the secretion of which it stimulates, depress its function, thereby regulating it somewhat in the manner of a thermostat. When the concentration of the cortical hormones exceeds a certain level, it is automatically controlled by suppression of the hormone which stimulates their secretion.

The chemical stucture of this anterior pituitary hormone is not known at this time. As will be seen presently, there are several cortical hormones, and the pituitary hormone can selectively stimulate the production of those which are needed It is not clear how this is accomplished. It is reasonable to assume that there are several pituitary hormones and the secretion of each one varies according to the needs of the body. There remains also the possibility that one hormone may determine the composition of the cortical secretion. Whatever the mechanism, the control of the anterior pituitary gland over the suprarenal cortex is a finely balanced one, for the cortex responds promptly and in a delicately balanced manner to the various situations which arise and which are under its control

The cortex of the suprarenal gland secretes at least twenty-eight closely related substances. There may be more, for there remains a residue which may contain still unidentified hormones. The known hormones fall into three groups: mineralocorticoids, glucocorticoids, and sex hormones. Each of these is found in minute quantities, and it is not clear whether the hormonal properties are contained in one or more of these substances. Nor is this distinction absolute, for the glucocorticoids contain some of the properties of the mineralocorticoids.

The cortical hormones are, chemically, closely related to cholesterol and to the sex hormones. In fact, cholesterol is the substance from which some, if not all the others, are formed. The cortex contains also large quantities of cholesterol, but when the organism is under great stress, the cholesterol disappears. It is thought that it is used up in the formation of cortical hormones which are needed to defend the organism The cortex also contains a large quantity of vitamin C which shares the fate of cholesterol, but its function is not understood, for it forms no part of the cortical hormones.

The mineralocorticoids are primarily concerned with water and mineral metabolism. Under physiological conditions, mineralocorticoids will tend to retain water, sodium, and chloride ions. They have many other effects not entirely understood. They will favor the excretion of potassium through the kidney. They also favor the excretion of renal pressor substance by the kidney into the blood stream. This is a very important substance, for it has to do with the regulation of the blood pressure, and it is involved in the formations of some forms of hypertension. It also causes changes in blood vessels and connective tissues which may play a part in arterial disease (arteriosclerosis, hypertension) and connective tissue diseases (arthritis, rheumatic fever).

In many ways the function of mineralocorticoids is antagonistic to that of the glucocorticoids, and it is not entirely clear whether some diseases, such as rheumatoid arthritis, are caused by lack of glucocorticoids or by disturbed balance between mineralocorticoids and glucocorticoids.

Diseases of Adaptation.—It is thus clearly seen that the glucocorticoids are most important hormones in the maintenance of homeostasis However, the appreciation of this fundamental defense system is still too recent to be fully understood, but there is little doubt that it plays a part in a very large number of diseases and in physiological adjustments. There is a growing belief that Selye may be correct in his concept of "diseases of adaptation" By this is meant that the "stage of resistance" to some form of stress becomes "derailed." The exact balance necessary to contain a stress without disturbance of structure or function is not developed and the patient develops what is called a disease. An example used to illustrate this principle is rheumatoid arthritis. The real cause of this disease is still not understood, but some form of stress, be it a bacterial toxin or nervous strain, causes a change in the structures of the joints There is increased permeability of the joint structures, and fluid exudes into the connective tissue, deformity, swelling, and pain result. The essential change in this disease process appears to be the change in the permeability of the tissues It was explained above that this function is under the control of the "corticoids", the mineralocorticoids favor it and the glucocorticoids prevent it The joint changes then are thought to result from a state of imbalance between

the anterior pituitary hormones, but among them is one (or more) which stimulates the suprarenal cortex. In this function the gland is largely governed by the thalamic centers of the brain and by adrenalin. The suprarenal cortical hormones, the secretion of which it stimulates, depress its function, thereby regulating it somewhat in the manner of a thermostat. When the concentration of the cortical hormones exceeds a certain level, it is automatically controlled by suppression of the hormone which stimulates their secretion.

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CHAPTER 5

DISTURBANCES OF NUTRITION

Introduction.—The simplest forms of "disease" would be those which result from inadequate or erroneous food intake.

Undernutrition or lack of food (inanition) will force the body to draw on its reserves to sustain the function of the more "vital" organs Expendable proteins are soon spent, then available fats and carbohydrates are burned up. The details of this process may be studied elsewhere. Here it must be noted that the starving body endeavors to protect the brain, the heart, and the kidneys, while stores of fat and organs which contain them are allowed to shrink. As starvation progresses it involves more than loss of food reserves; certain functions become disturbed. The body is now primarily concerned with survival and not with procreation, so sexual functions are disturbed· women experience menstrual disturbances, sexual desire wanes, and secondary sex characteristics waste *disproportionately The permeability of tissue membranes*, becomes less perfect, and the dependent tissues become dependent (hunger edema). The brain also is affected, and emotional and character changes develop. Withal, the cortical hormones endeavor to maintain the normal workings of the body, and the suprarenal cortex hypertrophies in contrast to the other organs.

Malnutrition may also be selective. The body requires protein or rather certain essential amino acids, contained in proteins, for continued life. If these are missing, the patient gradually weakens and dies, here, again, advanced protein starvation is associated with edema and other changes noted above Deprivation of a number of substances, such as calcium, iron, sodium, and others, results in more or less definite conditions of deficiencies which may be studied in detail elsewhere.

these two (groups of?) hormones, either an excess of mineralo-corticoids or a deficiency of glucocorticoids. More likely the latter is the explanation, for some cases of rheumatoid arthritis are markedly benefited (symptomatically) by the administration of additional glucocorticoids. It is clear that an additional local factor must also be present to produce arthritis, for in these cases the arthritic changes are marked out of proportion to other changes which theoretically would result from an imbalance of these hormones if all functions controlled by them were equally susceptible to an unbalance of them. The same sort of reasoning applies to other conditions which are thought to result from derailment of adaptation, such as peptic ulcer, allergy, lower nephron nephrosis. As stated before, the clinical manifestations are determined by the manner and degree of stress and by susceptibility of the individual structures or organs.

To complete the picture it may be stated that clinically these conditions may be influenced not only by administration of the hormones which are at fault, but also by administration of the pituitary hormone which stimulates their formation and liberation (ACTH).

There are also other defenses against agents which may disturb the proper functioning of the body, but these are more specific and will be considered with the discussion of the individual causes of diseases. This presentation has been introduced here to make it clear that "disease" is a contest between forces which tend to upset the normal "physiological" working of the body and those which endeavor to maintain it. Victory of the former will result in complete destruction of *function of an organ, even to the point of* death of the organism; victory of the latter means restoration of health.

It is, further, associated with a form of diarrhea which resembles pernicious anemia, and it has been thought that there is some relation between sprue and pernicious anemia.

Lack of vitamin C (ascorbic acid, cevitamic acid) results in fatigue, loss of energy, failure of appetite, soreness of the gums, bleeding, and loss of teeth. The tendency to bleeding becomes more general, with bloody diarrhea and hematuria. The resistance to infections is poor. The interest in vitamin C

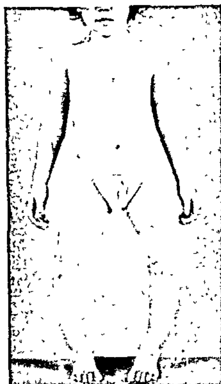


Fig. 16.—Rickets Bowlegs resulting from softening of the tibia and fibula (Courtesy Dr H R McCarroll, St Louis)

has been greatly increased with the observation that it is accumulated in the suprarenal cortex and that it in some ways plays a part in the body's defenses against stress. It is one of the few examples of how the functions of vitamins and hormones may be coordinated

Vitamin D is concerned with bone formation and calcium metabolism If it is lacking from the diet of infants, they

The Vitamins.—A great deal of interest has been aroused regarding vitamins. It has gradually become clear that the body requires for its proper functioning minute amounts of a number of different compounds of more or less complicated structure. Because these substances were at first known through their effects only, they were simply called by letters of the alphabet. Later, as they became chemically identified, they have, in addition, been given proper names. The effects of vitamin deficiency is described more in detail in Unit III (Pathology—How Disease Manifests Itself in the Body). Therefore, they shall here be briefly considered. An adequate well-balanced diet meets the normal vitamin requirements of the body. There is, therefore, no reason for healthy, well-fed persons to take additional vitamins. Excess of vitamins does not convey excess of strength or any other form of vitality. Vitamin therapy is indicated where the diet for some reason is or has been inadequate and when food is not adequately absorbed from the intestinal tract. Below, a brief listing will be given of the clinical manifestations of the principal vitamin deficiencies:

Deficiency of vitamin A results most strikingly in various eye disorders, especially of the cornea; it may cause night blindness. It is essential to growth, and lack of it may lead to weakness, gastrointestinal disturbances, and diminished resistance to infections

Vitamin B has in the course of time been discovered to be the designation for a number of different vitamins, including nicotinic acid and riboflavin. Vitamin B deficiency may lead to pellagra, pigmentation, roughening and scaling of the skin of the exposed parts of the body, atrophy of the tongue, gastrointestinal disturbances, anemia, and nervous symptoms. These are nervousness, headache, and peripheral lesions, first burning of the skin, then numbness, and last paralysis Pellagra may eventually prove fatal

Deficiency of vitamin B_1 (thiamine chloride) may cause beriberi, a condition especially prevalent in the East Indies; beriberi may manifest itself by nervous symptoms such as were noted above or by rapid cardiovascular failure with pulmonary edema. There is also a more chronic edematous form which resembles congestive heart failure. Sprue, or tropical diarrhea, may also result from vitamin B_1 deficiency.

that rats which eat to their hearts' content do not live as long as those whose diet is limited. It has also been noted that during periods when whole populations are on short rations, the incidence of the diseases mentioned below is definitely lower.

Overnutrition not only shows itself by excess deposits of fat; it also places other strains on the organism. Overweight persons show a marked tendency to increase in blood pressure—in fact, to the entire symptom complex of hypertension with arterial disease, coronary disease (angina pectoris and coronary thrombosis), and heart failure or cerebral hemorrhage. Their carbohydrate metabolism is also under a strain, and they are more likely to develop diabetes. Gall bladder disease, including gallstones, is also more common among those who are overweight. Some of these relationships may be explained through the principles of stress and the failure of the body to adapt itself thereto, but the details are rather complicated.

It is more difficult to produce disease by excess of vitamins; most of them can be tolerated in large amounts. Only vitamin D may in excess produce disturbances of the calcium metabolism manifested by deposits of calcium in the tissues, kidney stones, and calcification of the arteries.

The understanding of the proper dietary requirements is important in itself, for everybody should be well nourished, but it is also important in relation to the management of many diseases A large number of diseases are characterized by the failure of the body to handle some sorts of food (for example, diabetes); in others the diet must be modified so as to be compatible with the disease condition (for example, gastric ulcer); yet in all the caloric and vitamin requirements must be met.

develop rickets, a condition in which the bones harden late and, remaining soft, are subject to deformities according to the strain which is placed upon them. Vitamin D has a chemical structure which closely resembles that of cholesterol. In fact, it is derived, if not from cholesterol, at least from substances which closely resemble it. The human body can produce some vitamin D in skin exposed to the ultraviolet rays of the sun. It will be remembered that the structural formula of the corticoids and of the sex hormones also are closely related to cholesterol. This is another example of the close relationship between hormones and vitamins.

Vitamin E (alpha-tocopherol) is probably necessary for procreation. Effects of deficiency of this vitamin have not been demonstrated in man, but in rats lack of vitamin E has interfered with testicular activity and the females become sterile or their fetuses die.

Vitamin K is essential for clotting of the blood. It is produced in the intestine, apparently in adequate amounts. Deficiency arises from failure of absorption from the bowel and is characterized by an increased tendency to bleeding and failure of the blood to clot.

Overnutrition.—Excess of food may also be harmful. Even water in excessive quantities may produce a definite condition called water intoxication, but of much greater clinical importance is chronic hyperalimentation. A great many persons, especially as they pass through middle age, tend to eat in excess of their requirements At the same time many of them cut down on their physical activities. The result of such excess of calories is that food is stored about the body mostly in the form of fat. It is true that this tendency to store food is under endocrine control, both directly and also indirectly through regulation of the rate of metabolism which determines how much fuel the body requires for a given amount of work. However, these are functions which still render it feasible to control storage of food largely by the intake Only in rare cases is the "endocrine" factor so strong that obesity cannot be controlled by diet. While overweight cannot definitely be called a disease except in its extreme degrees, there is nevertheless evidence that it interferes with life expectancy. There is ample statistical proof that the death rate increases rapidly with increase in weight. Experimentally it has been shown

all infest the human body, especially of persons living under unhygienic conditions. The principal importance of such parasites is that they act as "vectors" and carry infectious diseases and inoculate their victims when they suck their blood.

Some parasites, such as hookworm and some tropical parasites, deprive their hosts of sufficient blood to cause anemia and general weakness. It has been stated that hookworm disease was long an unrecognized cause of the low social status of the poor white people in the South.



Fig. 17.—Trichinella encysted in muscle section. (Courtesy of Dr. Henry E. Meleney, New York City; Medichrome, Clay-Adams Co., Inc.)

MICROORGANISMS (INFECTIOUS DISEASES)

Introduction.—For centuries physicians fought diseases, now and then suspecting that some of them were caused by minute creatures which could be conveyed from patient to patient, but only the latter part of the last century brought recognition of these invaders and the manner in which they invade the body. Once the germs became known, the fight against them took three aspects.

1. Endeavors were made to attack them at the source, to prevent them from ever entering the human body.

CHAPTER 6

INFECTIOUS DISEASES

INVASION OF THE BODY BY HIGHER ORGANISMS (PARASITIC INFECTIONS)

Introduction.—Various animals are parasites of the human body; that is, they obtain their nourishment from the human body. Sometimes they make it their habitat (symbiosis), sometimes they visit it only for nourishment.

Worms.—Among the permanent sojourners of the body, the worms are the most important. Some of them live in the intestine (tapeworms and roundworms). Others migrate into the tissues (trichina, echinococci) The worms in the intestines are relatively unimportant, for they rarely cause symptoms Some animals, such as dogs, always have worms in their intestines Those which invade the tissues are more important: Trichinae invade muscles and cause painful muscular lesions, and echinococci form cysts which may grow to appreciable size and become infected and thus cause much trouble.

The worms generally have two hosts· fish and meat The eggs of the fish tapeworm are found in the muscle of fish; those of the beef and pork tapeworms, in cows and hogs, respectively. The worms are introduced into the human body if fish or beef or pork is eaten without being thoroughly cooked. Trichinae are found in pork which have eaten rats which are the normal host The larvae are then found in the muscle of the hog where their cysts may be recognized by inspection. Modern methods of inspection of slaughter houses have greatly diminished the incidence of these parasites.

Other Parasites.—Mites invade the skin and cause an itching rash known as scabies. Ticks, lice, fleas, and mosquitoes may

2. Methods were devised to help the body build up its own natural defenses *against infection:* to develop immunity.

3. A search began for drugs or substances which would prevent the growth of *microorganisms* in the body without harming the patient.

The scourge of infectious diseases is not yet abolished, but the fight has been eminently successful. In the modern civilized community, public health measures protect the individual citizens *against exposure to diseases,* such as plague, cholera, and smallpox, which formerly *interfered* greatly with health and life. Immunization can be rendered practically certain against such diseases as smallpox, diphtheria, or typhoid fever, and *in recent years drugs have been discovered which will prevent the growth of many organisms inside the human body; thus the threat of pneumonia,* syphilis, and many other infections has been *modified* for the better.

Nevertheless, infectious diseases are still with us, and it is necessary for those who work with sick people to know something about infections.

The Microorganisms.—The *organisms* which cause infectious diseases are many and varied. They constitute many degrees of differentiation from viruses through bacteria and mycoses to protozoa.

Viruses are the most primitive; in fact, their true nature is not known, *for they are so small that they pass through the fine filters used in bacteriological work.* They are, however, living things, for they can multiply themselves *and they* possess activities beyond that of mere chemical action. Some believe that they constitute a very primitive form of life without morphological organization. There are a great many different kinds of virus, because they can be isolated and shown to produce clinical conditions, each of which has its own signs and symptoms, each of which can be transferred and reproduced from person to person, and against each of which specific immunity can be developed. Viruses have been, and to some extent, still are, responsible for some of the most important infectious diseases, such as influenza, smallpox, infantile paralysis, which from time to time have occurred in great epidemics.

Rickettsiae is a generic term for a group of organisms larger than viruses, for they can be recognized as such, and smaller than bacteria. They enter and live within the cells of the body. They stain poorly with the ordinary dyes. They comprise the typhus fever group, spotted fever and Q fever.

Bacteria are somewhat higher on the scale. They are organized into shapes which can be recognized under the microscope, take stains, and are sometimes seen to multiply by means of "spores," still smaller, organized bodies which form inside them. Large numbers of organisms are known, but only

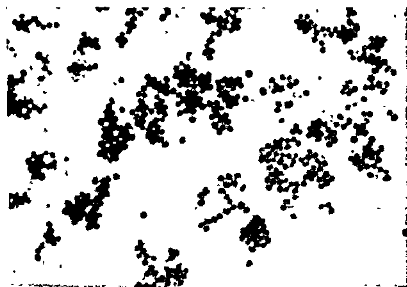


Fig. 18.—Gram stain of staphylococcus (Courtesy of Dr. Gregory Shwartzman, New York City; Medichrome, Clay-Adams Co., Inc.)

a limited number are pathogenic; that is, known to cause disease. They are classified according to their shape, their staining qualities, and the manner in which they grow, including the media which favor their growth. It is possible to make them grow on broth, blood, or other specially prepared substances called media. Some will grow with access to air; others grow only in the absence of air, deep in the medium. Only a few typical ones will be mentioned here.

The staphylococci grow in small clusters. There are two forms, *Staphylococcus aureus*, which grows in yellow colonies,

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Diplococci grow in pairs and in the body are surrounded by a well-defined capsule. There are three important kinds. The pneumococci (*Diplococcus pneumoniae*) are responsible for lobar pneumonia. They stain with Gram's stain and are therefore called Gram positive. About seventy different types of pneumococci are known. Other diplococci fail to stain with Gram's stain. They are said to be Gram negative. Two species of these are the meningococci, which cause epidemic spinal meningitis, and the gonococci, which cause gonorrhea.

Bacilli are rod shaped; the rods may be club shaped, curved, or simple and straight. They have many different staining and morphological qualities Some stain with acid and are called acid-fast; the tubercle bacillus falls in this class. Others cause diphtheria, typhoid fever, and cholera Some bacilli form spores. The spores of *Bacillus anthracis* is especially well demonstrated.

A gradual transition from simple bacilli to organisms which grow in branching filaments has been noted. These are called *mycoses* and are considered morphologically of somewhat higher standing than the bacilli. Actinomycosis is caused by such an organism. During recent years several other mycoses have been found to be pathogenic Several attack the lungs where they form lesions which are extremely resistant to treatment.

Spirochetes are another group of rather highly organized bacteria. They are spiral shaped. Some of them survive with difficulty outside the human body and are extremely difficult to grow. Conversely they have been very difficult to eradicate once they became well established in the human body. Some of the best known are *Treponema pallidum*, which causes syphilis, and the spirochete which causes Vincent's angina.

Moving further up the scale, the *protozoa* are definitely recognized as belonging to the animal kingdom though they are still unicellular They do, however, pass through several generations and some undergo sexual differentiation Malaria is the most important disease caused by protozoan infection. The protozoa which cause it are called plasmodia *Plasmodium malariae* causes quartan malaria, *Plasmodium vivax*, tertian malaria, and *Plasmodium falciparum*, the estivo-autumnal type of malaria

and *Staphylococcus albus*, which grows in white colonies *Staphylococcus aureus* is the more virulent. This form is found on the skin and is responsible for skin infections. Occasionally the infection becomes generalized and the germs enter the circulation (bacteremia), and secondary abscesses may form in various parts of the body (bones, kidney). In these cases they cause severe constitutional changes with high fever. Staphylococci are pyogenic; that is, they tend to form pus where they grow.

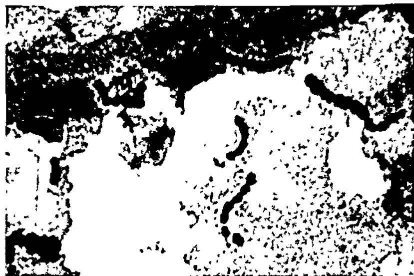


Fig 19 —Gram stain of streptococcus. (Courtesy of Dr. Gregory Shwartzman, New York City; Medichrome, Clay-Adams Co, Inc)

Streptococci grow in curved chains They constitute a large and miscellaneous group and are probably responsible for more infections than any other group of organisms

A group of streptococci are hemolytic. This group includes many of the most important pathogenic germs. It has been subdivided into a number of subgroups (A, B, C, D, E, F, G, H, K, L, M, N); each of these is in turn subdivided into types Thus, there are twenty-seven types of hemolytic streptococcus A; among these are the ones which cause scarlet fever, erysipelas, puerperal sepsis, and other infections.

Another group is typified by *Streptococcus viridans*. It is the most common cause of subacute bacterial endocarditis

Some organisms are rather delicate and survive poorly outside the human body. They spread mostly through intimate contact such as kissing or sexual intercourse. The so-called venereal diseases are classed together because they are disseminated in this manner. Otherwise they vary greatly, and they are caused by greatly different organisms.

Many infections are spread by "vectors," mostly insects which carry the organisms and transmit them through their bites or excreta. Mosquitoes carry malaria and yellow fever, ticks carry spotted fever, and lice transmit relapsing fever. Rickettsial diseases are spread by rubbing or scratching the skin covered with the excreta of the insects which spread them.

Some infections are spread through bites of animals the saliva of which is infected. Hydrophobia is the outstanding example of this mode of spread

Finally, there remains a number of infectious diseases in which the manner of spread is still unknown. Some of these, such as poliomyelitis and some forms of encephalitis, occur in large epidemics. Having entered the body, the infecting organism may behave in many different ways They may remain near the port of entry, causing a localized lesion, such as a boil or an abscess, or they may secrete substances harmful to the body; these are called toxins and may enter the circulation and thus attack certain organs for which they have affinity This is the manner of diphtheria; the bacilli will remain in the throat, but the toxins will attach themselves to nerves or myocardium and there cause important changes.

Infections which enter the body usually enter the lymphatics or the blood stream and thus become generalized. Others, such as tetanus or hydrophobia, will travel along the nerves, these infections, as a rule, confine themselves to the nervous system. Generalized infections may remain such (septicemia), or the infection may have affinity for certain organs, or organs may individually be below par and thus create a place of minor resistance. Examples of organisms which prefer certain organs are pneumococci, which most often affect the lungs, and meningococci, which show preference for the membranes of the central nervous system. Streptococci and staphylococci will affect any part of the body which happens to show lowered resistance. *Streptococcus viridans* holds a

These plasmodia appear in two forms: a simple asexual form, which is called sporozoite, and the gamete, which is sexual, more highly developed; and ameboid. The sporozoites are found in the salivary glands of mosquitoes which transmit the disease when they bite a human being. The sporozoites then attach themselves to red cells which they invade and destroy, multiplying in the process. Eventually during the infection the gametes appear. This is a much more complicated condition than a simple bacterial infection.

Other protozoan diseases are amebic dysentery and trypanosomiasis. The amebae of dysentery are simply transmitted with infected food and drinking water. Trypanosomiasis causes two important diseases: An African form causes sleeping sickness and is transmitted by the tsetse fly and the South American form causes Chagas' disease. It is transmitted by the "kissing bug," a large ugly 2 cm. long insect which lives in poorly kept houses.

These are but examples of a host of pathogenic organisms, but they illustrate the great variety of microbes, each of which might destroy the human race if it meets with no resistance.

Modes of Invasion.—It has already been indicated that pathogenic organisms enter the human body in many different ways.

The simplest manner is to enter with contaminated food or drinking water. Cholera, typhoid, and dysentery spread in this fashion. Having entered the gastrointestinal tract, the organisms may remain there and form their lesions in its wall, such as typhoid or dysenteric ulcers, or they may penetrate the intestinal wall and invade the body proper, circulate in the blood stream (bacteremia), and locally attack organs or structures for which they have a special affinity.

The respiratory tract is another avenue of infection: germs may be carried on droplets of saliva spread by coughing (pneumococci or tubercle bacilli), or they may be contained in dust (anthrax). Dust-spread organisms are generally hardy and able to survive well under adverse circumstances outside the human body.

Relatively few infections enter through the skin, and those mostly through skin broken by previous injury (tularemia, tuberculosis).

Immunity may be active or passive. Active immunity is developed by the body or is originally possessed by it; passive immunity is conveyed to the body with serum from another person or animal which is actively immune. Immunity may be congenital or acquired. Congenital immunity often, but not always, lasts through life and it, or the lack of it, may be an individual, racial, or "species" characteristic—for instance, one member only in a family may develop an infection to which the whole family has been exposed; the Negro race is especially susceptible to tuberculosis; and foot and mouth disease affects commonly cattle and rarely man Acquired immunity is generally of limited duration, though in some cases it may be permanent. Immunity to common colds may be very brief, to pneumonia it may be longer, and few persons develop smallpox more than once.

Notwithstanding what has already been said, the resistance in a given person varies from time to time Certain infections are likely to develop during childhood (children's diseases), during certain seasons (colds during winter time), or when the general resistance has been worn down by stress and strain (the inmates of concentration camps or prisoner of war camps showed poor resistance to infections) Sometimes an infection will change its clinical aspects through centuries; this, in part, may be because the community where it is found changes its immunological reaction to it It may, however, also be because the virulence of the infecting organisms changes Thus tuberculosis does not now appear to be nearly as virulent as it was fifty years ago; in the sixteenth century, syphilis assumed the aspects of a deadly pandemic, as did influenza about 1918

The mechanism of immunity is not entirely understood It is only one part of the defenses of the body against the infection: fever, leukocytosis, and the general inclination of the infected person to rest are other defenses, and the general pituitary-cortical defense reaction against stress also comes into play There is some evidence that the development of immunity is a feature of it

For the understanding of the principles of immunity the following theoretical concepts are useful To some extent they are more factual than theoretical

It is generally assumed that pathogenic microorganisms produce and secrete some substances called toxins They are

somewhat intermediate position; it will especially attack the heart valves if these have been previously damaged by congenital or rheumatic defects.

The manner in which infecting organisms invade various tissues or organs of the body also varies greatly with the characteristics of the organism and the resistance shown by the tissues. In some cases germs will be stopped before they are able to multiply. They are killed and carried away, or they may become inactivated and remain dormant for an indefinite period. This is especially the case with such chronic infections as tuberculosis or syphilis which may remain asymptomatic for many years and then eventually manifest themselves in some organ far from the original port of entry, such as the central nervous system or some joint. In other cases the invader will set up a limited struggle but is eventually overcome, though not without some damage to the tissue where the infection has occurred. Fibrous tissue and scarring develops, and the patient will be left with a permanent scar. In the case of pyogenic organisms, this stage has been accompanied by the formation of pus which has then been either absorbed or drained. As long as pus is present in the body, it is a drain on its defenses and may be a source of general ill health. It is also a potential source of "metastatic abscesses": Some germs may be carried to other parts of the body and there set up new foci of infection, perhaps with abscess formation.

Other infections are more generalized. The organisms multiply in the blood stream and soon swarm over the entire body, causing a state of general septicemia as is seen in the rickettsial diseases and in malaria. The outcome of such generalized infections depends upon the development of the body's general defensive forces which are called immunity.

Immunity.—Immunity is a specific quality which enables the body to overcome specific infections or even types of infections. This explains why some patients who have just recovered and presumably acquired immunity against pneumonia again fall victim to it. They have become infected with another type. It is also specific in the sense that it is in no relation to the other body defenses. Persons of strong physique may prove susceptible to certain infections to which weaklings are resistant.

infection lasts for a few days or weeks at the most; it is generally violent and so are the responses to it. Pneumonia is an acute infection. A chronic infection extends over months or years; often the manifestations are mild but lasting. There may be periods of more acute activity. It is largely a matter of the body defenses being strong but still not adequate to overcome the infection. If periods of quiescence alternate with periods of activity, the infection is considered "intermittent." "Subacute" is used to designate an infection of virulence between acute and chronic.

the ones which create the harm which is done to the patient's body. They also possess the quality of evoking a defense mechanism in the body, that of developing immunity against the disease. Immunity is supposed to be embodied in certain substances called antibodies. These, however, are known through their action only and through the fact that the reticuloendothelium, certain globulins, and the leukocytes are concerned with their production.

According to their action, antibodies are classified as antitoxins, agglutinins, immune bodies, and opsonins.

Antitoxins are antibodies produced by the body tissues in response to bacterial toxins which they neutralize. They are found in the serum which thus has the quality of overcoming infection even when injected into another person, who thus acquires passive immunity.

Agglutinins are antibodies which cause bacteria to gather *into clumps; this process is called agglutination.* The part which agglutination plays in the development of immunity is not known, but this property is of value in diagnosis. If a person has an infection of undetermined nature, a small amount of this serum may be added to suspensions of various bacteria which are suspected of causing the infection. If the right one is included, it will agglutinate and thus establish the diagnosis This test is, however, subject to certain qualifications which are discussed in bacteriological texts.

Immune bodies require a third element to become active against infection This element is called a complement. Thus they form a link between the toxin and the complement: they are, therefore, called amboceptors (that is, those which take both). The complement is unstable and is not present in some commercial antibacterial sera. When these are given, it is necessary to add complement (for example, in fresh blood as transfusion).

Opsonins are antibodies which enable leukocytes and the reticuloendothelial cells to destroy invading organisms. This is an important step in overcoming infection. Opsonins are specific; they will enable the leukocytes to "phagocytize" only one kind of organism. Phagocytosis means absorption and destruction of the invading organism by cells.

According to the manner in which microbes attack patients, infections are called acute, subacute, and chronic. An acute

phile cells are of special importance to the present subject. Lymphocytes serve an important function in the body defenses against infections and other harmful agents. While the details are not known, reticuloendothelium has to do with the formation of gamma globulin which is a protein and which was mentioned in the preceding section. Gamma globulin is an important constituent of plasma. It is increased in certain diseases.

The Mesenchymatous Tissues.—The mesenchyme has been further differentiated into a number of tissues with fixed cells. It is the source of the so-called fibroblasts, which form collagen. This is the basic structure of connective tissue; further, the mesenchyme is the source of myoblasts, which form muscle cells; chondroblasts, which form hyalin, the basic sub-*stance of cartilage; and of osteoblasts, which form bone.*

All of these mesenchymatous tissues are in some way involved when the body is invaded by some substances which, somewhat vaguely, have been called antigens. Antigens include a great variety of substances They may be metallic, such as gold or arsenic, or compound chemicals, such as sulfa drugs or proteins. More specifically, they may be derived from bacteria. Some of them are known only by their effects. The exact mode of action of the antigens is not known, but the body develops against them substances which are called antibodies. In Chapter 6 the antibodies which are developed specifically against bacterial toxins were discussed somewhat in detail. Here the term is used in a broader sense to mean any agent which will neutralize the action of antigens. It was stated that the chemical structure of bacterial antigens was unknown. The same statement applies to all the other antigens

When antigens invade mesenchymatous tissue, two things happen: the basic substance degenerates into fibrous tissue, and it becomes more permeable to tissue fluids. Exudation takes place and here accumulate various kinds of cells of mesenchymal origin into groups or "bodies." Sometimes these cells are lymphocytes, sometimes eosinophiles, and sometimes other kinds of mesenchymatous cells Depending upon whether fibrosis or exudation prevails and upon the kind of cells which congregate, there will result different pathological pictures and different clinical syndromes which are known under various technical names

CHAPTER 7

DISEASES OF THE MESENCHYME

Introduction.—Scattered through medical texts are found descriptions of diseases of which the cause was not understood and they were, therefore, classified according to their principal manifestations. Many of them seemed to follow recognized infections or to have other qualities which resembled those of infectious diseases, and it was thought that they were infections of which the causative organism had not yet been found. In the course of time it was learned that those diseases to which reference here is made had in common involvement of the mesenchyme. Recently an attempt has, therefore, been made to group them together as "diseases of the mesenchyme." This classification has assumed great practical importance because it appears that this group is especially amenable to treatment with cortisone and ACTH.

The mesenchyme is a primitive supportive substance in the embryo. As the embryo develops, the mesenchyme differentiates into various structures, each of which is characterized by the kind of cells which it contains. All of these structures retain a primitive function of reacting to certain stimuli in a manner which is thought to be essentially defensive. However, under certain conditions these responses become modified in such a manner that they interfere with the normal functions of the tissues. The result is certain syndromes or "diseases" which have been classed together as the "mesenchymatous diseases" or, less accurately, the "collagen diseases."

The reticuloendothelium is one of the most important of the mesenchymatous tissues. It forms a substantial part of the supportive tissues of the blood-forming organs, the bone marrow, and the lymphatic organs. From it are formed the lymphocytes and also the granulocytes, of which the eosino-

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Among the structures of the body, serous membranes, muscle tissue, the tissues supporting blood vessels, the structures surrounding the joints, and the skin are peculiarly susceptible to these changes. If these tissues have once been *exposed to an antigen and have recovered, they may be left* hypersensitive, and if they subsequently are re-exposed, they may respond in a manner altogether excessive. It is thought that many "diseases" of the mesenchymatous tissues represent such excessive or *"allergic"* responses to antigens.

The Allergic Diseases.—The "allergic" diseases are characterized by acute, or even temporary, localized responses to antigens which for this purpose are called allergens. *Allergic* lesions consist largely of exudates into and from the affected tissues with resulting swelling or "rashes" if the skin is affected. Allergic reactions are further characterized by the accumulation of eosinophile cells both locally and in the blood stream.

In rheumatic fever, cells accumulate in the myocardium and *in the tissues which support the blood vessels and those which* surround the joints Rheumatoid arthritis resembles rheumatic fever in some respects, but the lesions are more chronic. There are proliferative changes in the fibrous tissues, cartilages, bones, and about the joints, but there are *also* lesions — accumulations of cells — elsewhere in the body. In both of these rheumatic diseases the globulin is increased in the blood In lupus erythematosus, similar lesions may be widespread throughout the body.

In all of these diseases the symptoms may develop following the invasion into the body of known antigens or from unknown *causes*. The manner of the response depends upon the nature and amount of the antigen, the resistance of the patient, and the susceptibility of the individual tissues Hence, though the principle may be simple enough, the clinical conditions which result may vary greatly.

One other factor influences the mesenchymatous response greatly. The glucocorticosterones have an important effect upon these processes They counteract the fibrotic response and cause the tissues to lose their excessive permeability, so that swelling and deformity return to normal. In recent years it has been possible to administer corticoids and thus modify the course of the diseases. The patients experience a feeling

of well-being, the local lesions improve, and the eosinophilia and hyperglobinemia disappear. It is the response of the tissues which is modified, but only so long as the corticoids are active. When they are no longer effective, the original disease again manifests itself and the symptoms return. For the cure of these diseases it is necessary, as in the case of infections, either to enable the body to produce antibodies against them or to learn how the antigens can be destroyed before they affect the tissues.

CHAPTER 8

DISEASES OF THE VASCULAR SYSTEM

Atherosclerosis and Arteriosclerosis.—The arterial wall is susceptible to some changes which are known as atherosclerosis and arteriosclerosis. In atherosclerosis the intima of the blood vessel undergoes fatty degeneration: Lipoids (that is, fatlike substances) are deposited in the cells, and they lose their smooth shiny surface. This is generally the earlier lesion Later the media also becomes involved, fibrous tissue increases, and calcium salts are deposited. The wall loses its regular outline and becomes hard and irregular, and, as the condition advances, the blood vessel becomes tortuous instead of straight. Altogether the vessels become less efficient, and the changes of the surface of the intima favor thrombosis (that is, clotting of the blood, with the clots becoming attached to the vascular wall) in the diseased vessels Depending upon the degree of thrombosis and consequent restriction of the lumen, the carrying power of the vessel is impaired; it may be blocked altogether Such interference with the blood supply will, of course, have an important effect upon the tissues and organs which these blood vessels supply.

The causes of these changes are not yet understood, but "stress," be it emotional, physical, or metabolic, is thought to play an important part in its development Clinically, they seem to occur more frequently in persons who live under great pressure, have high blood pressure, or have certain metabolic disturbances. Hypertension is closely linked with arteriosclerosis, and "stress" plays an important part also in its development. Cholesterol is deposited to excess in arteriosclerotic vessels where it acts as an irritant and may be the directly exciting cause of the other changes. Age is also important. Generally, arteriosclerosis advances with age, though

there are many exceptions to this rule: Early atherosclerotic changes may occur in early life and sometimes arterial disease advances rapidly in early middle life. It is also possible to find older persons with remarkably "youthful" arteries. Selye has suggested that there is a strong relationship between these changes and those just described. In fact, he believes that they are all due to the same fundamental process of "stress" but that arteriosclerosis represents a more advanced stage, passing toward the "stage of exhaustion," which is finally reached when the circulation breaks down completely to a certain area, such as the brain or the kidney. These views require confirmation, but the fact remains that arterial disease is fundamentally a "mesenchymal" disease; only secondarily are we dealing with diseases of the organs whose blood supply is impaired.

As the population of this country ages, this group of diseases increases in importance; it constitutes the most important chapter of gerontology. Arteriosclerotic changes are peculiarly selective. They may affect the vascular system generally but more commonly is one or two vascular areas affected out of proportion to the rest. Arteriosclerosis is known mostly through its effects upon the function of essential organs.

When arteriosclerosis becomes marked in a large area of small-sized arteries or of the arteries to some vital organ, the blood pressure will increase in an attempt to maintain the circulation, but this establishes a vicious circle, for, as has been stated, the higher pressure accentuates the vascular changes.

Arteriosclerotic Changes in the Brain.—These generally develop in an insidious manner. They may interfere with intelligence, memory, and emotions. The so-called senile mental conditions are caused by such changes. Sometimes, especially in the presence of hypertension, serious accidents may occur, either thrombosis or extravasation of blood into the brain substance. Clinically these are known as "cerebral accidents". Various parts of the brain may become entirely inactivated. Frequently such accidents occur in the internal capsule with paralysis of the motor nerves which pass through. Paralysis of one side of the body is hemiplegia It is often fatal

The Coronary Arteries.—Arteriosclerosis is also common in the coronary arteries. If the process develops slowly, collateral circulation may develop, and sometimes coronary dis-

ease may become quite advanced without causing symptoms. However, in most cases the coronary circulation fails sooner or later. Whenever the arteries of the heart are called upon to carry more blood (for example, on effort, during excitement, etc.), they fail to do so. Inadequate blood supply to the heart results in pain which is generally felt in the chest but which may radiate to other parts of the body. The diseased coronaries are also susceptible to more or less sudden developments of thrombosis which may block off the circulation to larger or smaller areas of heart muscle (myocardial infarction). This condition is generally very painful and always very serious; in many cases it causes rapid or sudden death.

Vascular Disease of the Kidneys.—This generally results in progressive impairment of their function; this condition is called chronic nephritis. It may remain latent for many years but will eventually result in uremia, which is kidney failure. This may be chronic and go on for years, for patients can adjust themselves to live with impaired kidney function. Vascular disease of the kidney is generally associated with hypertension. As a matter of fact, renal ischemia results in the secretion of a substance (renin) which will activate a globulin (hypertensinogen) produced by the liver into "hypertensin" which will cause hypertension.

Other Arteriosclerotic Conditions.—Arteriosclerosis will also impair the circulation to the legs, so that the leg muscles will fail on prolonged walking; pain forces the patient to stop (intermittent claudication). Advanced arteriosclerosis may also cause profound insufficiency of the circulation, with death (gangrene) of the extremity. This is the arteriosclerotic gangrene seen in elderly persons.

Arteriosclerosis of the mesenteric arteries may cause a rapidly developing and extensive thrombosis which will cause extensive infarction of the intestine. Clinically there results an acute abdominal condition which carries a high mortality

These are examples of the more important vascular diseases. Until quite recent times their pathogenesis has remained obscure. However, recently so much effort has been concentrated upon their study that it now seems probable that a better understanding will soon develop which will hold the key to their cure and prevention.

CHAPTER 9

DISTURBANCES OF INTERNAL SECRETION

Introduction.—It was previously (p. 42) noted that the famous French physiologist, Claude Bernard, about 100 years ago showed how the body maintained a "milieu intérieur" with checks and balances, resistant to all changes. He could not know to what extent it would be shown that this principle governs the human body, but since his time it has been discovered that the whole system of endocrines maintains this function. This is partly done through secretions which directly affect organs (the antidiuretic hormone from the posterior pituitary) or functions (insulin affecting blood sugar) and partly through secretions affecting other endocrines (pituitary controlling the thyroid), thereby balancing the effects of the various hormones. Many of them are antagonistic to each other, as in the case of adrenalin and insulin. Adrenalin will increase the blood sugar and insulin will depress it The two groups of hormones from the suprarenal cortex, the mineralocorticoids and the glucocorticoids, are in many respects antagonistic

A short review of the physiology of the endocrines would facilitate the understanding of the disease of this system. In general, tumors may develop and result in excessive function of the organ, there may be overfunction without tumor formation, and there may be less than normal function, sometimes associated with degenerative changes in the glands. Some disturbances of the endocrines are very common, for instance, hyperthyroidism, while others are rare, but in view of our growing knowledge of these glands even the rare conditions assume importance.

The Pituitary Gland.—The pituitary gland has a key position in the endocrine system. Its relation to the suprarenal cortex in the defense system of the body has been discussed.

Diseases may affect separately the posterior and the anterior lobes Involvement of the posterior pituitary or hy-

pothalamic centers which control it may result in disturbances of secretion of antidiuretic hormone. The result is that the patient secretes an excessive amount of urine, and to compensate for this he will drink a corresponding amount of fluid. The disease develops gradually in young persons, mostly in males, and the water intake and output may reach 10 to 12 liters per day. Often no pathological lesion is demonstrable. More diseases of the pituitary gland affect the anterior lobe. Among its many functions, the pituitary gland is responsible for growth, and underfunction may result in dwarfism. Simmond's disease is also the result of decreased hypophyseal activity. It attacks mostly women in middle life. They undergo progressive emaciation with loss of sexual function and axillary and pubic hair and atrophy of the breasts. There is an associated dysfunction of the other endocrines.

The corresponding overfunction of the pituitary results in gigantism in youth and acromegaly in later life. Acromegaly results in overgrowth of the jaws and peripheral extremities.

Fröhlich's syndrome (adiposogenital dystrophy) is seen mostly in youth. Boys develop a feminine body type, adiposity largely about the hips and lower part of the trunk, and genital underdevelopment.

Cushing's disease affects jointly the anterior pituitary and the suprarenal cortex. It is a disease of middle life, and most cases occur in women who develop obesity, especially about the trunk, hypertension, hirsutism, amenorrhea, and a tendency to glycosuria—all of these are functions of the suprarenal cortex but under the control of the anterior pituitary. Some patients have tumors of the pituitary, and others have overgrowth of the cortex. The exact mechanism of these conditions is quite complicated.

The Thyroid Gland.—The diseases of the thyroid gland were some of the endocrine disorders which were first discovered and of which the clinical pictures stand out most clearly

The thyroid gland may suffer acute inflammation: It becomes red and swollen, and the patient develops signs of hyperthyroidism and also general evidence of infection

In a more chronic way, hyperthyroidism may result from the formation of benign localized tumors or adenomas Many of these, however, are not associated with thyroid overac-

tivity. The typical Graves' disease is most generally caused by diffuse hyperplasia of the gland. Most of these patients are young adults, more commonly women. They become nervous, "jittery," and develop a fine tremor of the fingers and a flush of the skin. They also lose weight in spite of a better than normal appetite. The cardiovascular system is profoundly affected. In fact, originally hyperthyroidism was thought to be a disease of the heart. The heart rate increases, typically to about 120 (tachycardia). The patient feels palpitation, with the peripheral vasodilation. The difference between the systolic and diastolic blood pressures increases, and the speed at which the blood circulates increases also (the circulation time is shortened). The heart action may become irregular, auricular fibrillation, and older persons with long-lasting hyperthyroidism may develop heart failure. The sugar metabolism may also suffer and the patient develop glycosuria which resembles diabetes. There is also prominence of the eyes (exophthalmos).

Malignant neoplasms of the thyroid may start as such or adenomas may become malignant This form of cancer is peculiar by the fact that not only do its cells, but also those of its metastases, retain the function of the original gland. Therefore, cancer of the thyroid gland may show evidence of hyperthyroidism.

Failure of thyroid function may assume various clinical aspects Children may be born with thyroid deficiency, especially in certain regions where the soil and drinking water are low in iodine. These patients are poorly developed, have coarse features and hair, and have low intelligence They are called cretins About the time of the menopause, when other involutions occur, some persons develop myxedema; that is, underfunction of the thyroid gland. They lose their energy, their features coarsen, and they develop nonpitting swelling of the subcutaneous tissues. The same picture develops if the thyroid gland is removed surgically. All of these conditions can be relieved by taking extract of thyroid gland by mouth

The Parathyroid Glands.—Behind the lateral lobes of the thyroid gland are the parathyroid glands They may be responsible for two conditions. Tumors of the parathyroid glands may result in increased activity. Inasmuch as they regulate calcium metabolism, overfunction results in excessive mobili-

pothalamic centers which control it may result in disturbances of secretion of antidiuretic hormone. The result is that the patient secretes an excessive amount of urine, and to compensate for this he will drink a corresponding amount of fluid. The disease develops gradually in young persons, mostly in males, and the water intake and output may reach 10 to 12 liters per day. Often no pathological lesion is demonstrable. More diseases of the pituitary gland affect the anterior lobe. Among its many functions, the pituitary gland is responsible for growth, and underfunction may result in dwarfism. Simmond's disease is also the result of decreased hypophyseal activity. It attacks mostly women in middle life. They undergo progressive emaciation with loss of sexual function and axillary and pubic hair and atrophy of the breasts. There is an associated dysfunction of the other endocrines.

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The Suprarenal Gland.—The suprarenal gland is composed of two entirely different parts which also embryologically are of different origin.

The function of the medulla was first understood, and its secretion, "adrenalin," was one of the first hormones to be isolated. Tumors of the medulla (pheochromocytoma) may secrete adrenal or adrenalin-like substances which cause marked increases in the blood pressure. This hypertension is paroxysmal and associated with giddiness, weakness, headache, and vomiting.

The medulla and its diseases have aroused great interest in recent years. *Almost a hundred years ago Addison described* the condition in which progressive weakness, asthenia, and pigmentation were associated with degenerative changes of the adrenal gland, but the detailed relationships of these factors were not known until quite recent years. It was then discovered that the cortex of the adrenals secretes a large number of closely related substances, called steroids, and that these steroids regulate a great many functions in the body and are part of the defense mechanism which was described on p. 62.

If Selye is correct, disturbances of cortical function form a part of almost all diseases There remain a few disturbances which are caused directly by tumors or destruction of the suprarenal cortex. Reference was made above to Addison's disease: Tumors or tuberculosis may destroy the gland or, in some cases, simple atrophy may occur The condition is most common in young adults, who gradually develop lassitude and weakness *which become increasingly* severe. Gastrointestinal disturbances (anorexia, nausea, vomiting, and diarrhea) develop, and the blood pressure falls; low blood pressure is typical of the condition. Pigmentation develops, especially of those parts which are exposed to sunlight and the mucous membranes. There is also a shift in the blood chemistry in that sodium and chlorides fall while potassium increases. Formerly the condition was inevitably fatal It is now possible to prolong life through the administration of salt and substitution of cortical hormones

It was also mentioned that the cortex secretes a sex hormone. Certain tumors of the cortex are associated with oversecretion of this hormone. The male characteristics predominate. The condition is most typical in boys and girls who develop

zation of calcium. The bones lose their calcium, become transparent to x-rays, and become the seat of cyst formation (osteitis fibrosa cystica). The mobilized calcium causes increase above normal of the calcium level in the blood stream and as it is secreted through the kidneys, it may there become precipitated and cause kidney stones.

The opposite condition may obtain if the parathyroid glands have inadvertently been removed in the course of thyroidectomy. It is called tetany and is associated with an abnormally low level of calcium. The same condition may result if the diet constantly contains too little calcium. Tetany is associated with irritability of the muscles, quite mild at first, increasing to severe spasms in advanced cases when they may last for hours and become very painful.

The Pancreas.—The pancreas is a mixed gland. The larger part of it secretes digestive enzymes, but it also contains small bodies of cells with endocrine action, the isles of Langerhans. They secrete insulin which is essential for metabolism of glucose. Failure of these glands results in diabetes: The body becomes unable to burn glucose; it accumulates in the blood (hyperglycemia) and is excreted in the urine (glycosuria). When diabetes becomes severe, there is also failure of the metabolism of fats; fatty acids accumulate in the body and draw heavily upon the alkali reserves of the body, and acidosis develops. If this is allowed to become severe, the patient may become unconscious and sink into diabetic coma Chronic diabetes, if untreated, is characterized by the excretion of sugar in the urine, excessive urine (polyuria), excessive thirst (polydipsia) and hunger (polyphagia), in spite of which the patient loses weight and strength. This picture develops most commonly in young persons. In older people diabetes frequently develops slowly and may be associated with overweight.

Overaction of the isles of Langerhans may result either from a benign tumor of an island or a malignant one with metastases, usually to the liver. These patients develop hypoglycemia; that is, low blood sugar. Low blood sugar causes weakness and sweating which is readily relieved by taking sugar or fruit juice. If it is allowed to advance, the patient may suffer mental abberrations when he is no longer responsible for his actions.

CHAPTER 10

NEOPLASTIC DISEASES

Introduction.—One of the greatest unsolved problems in medicine is why certain cells in the body assume independent uncontrolled growth in a manner which eventually will kill the host unless their growth is checked.

As other diseases have been brought under control, neoplastic diseases have become more important as a cause of death. This is partly because neoplasms occur more frequently in older persons and more people now live to an age when they are likely to develop these diseases, and it is partly because diagnosis is now more accurate and more cases of neoplasm are counted as such in the statistics

The fight against neoplasms is waged upon three fronts. Much research is being done to discover the *cause* of neoplastic changes. Many valuable observations have been made, but the cause remains unknown. The greatest care must be used in applying observed facts, for naturally much work has been done on animals, and facts observed in one species are not necessarily applicable to another, and the behavior of one kind of tumor may be quite different from that of another.

The cause of most neoplastic diseases being unknown, there is at present no way of preventing them, but because the results of treatment rapidly deteriorate as the tumor grows, *early diagnosis* is imperative. This requires the cooperation of the public, and much effort is now spent to educate the laity in the value of routine health examinations and in early investigation of all suspicious lesions

Finally, the technique of *treatment* is being constantly improved. At present it takes two lines: radiation of those

"pubertas praecox" and pseudohermaphroditism. In adults are seen more commonly milder forms of these conditions. Some of these tumors are malignant.

The Gonads.—There remain the gonads, which also are subject to various disturbances. Many of these, such as menstrual disturbances, are so mild as almost to fall within physiological limits. All of the genital systems are subject to tumor formation, but the only one which at present appears to be definitely associated with endocrinic dysfunction is the hyperplasia of the prostate which occurs in elderly men. It is evident that the growth of the prostate is under the control of the male sex hormone, and it is thought that the readjustment which occurs about the time of the male menopause may encourage hyperplasia of the prostate. It has been noted that this disease is markedly slowed by orchidectomy or by treatment with female sex hormones.

Disturbances of gonadal function proper rarely come within the scope of clinical medicine. The subsidence of gonadal activity is sometimes associated with constitutional symptoms, some of them of psychic character Thus, the menopause is both in men and women sometimes marked by mental disturbances (such as depression), hot flushes, palpitation, and other indefinite symptoms In some cases these symptoms are improved by substitution therapy (estrogens in women and androgens in men), but the effect is indefinite and seems to carry a marked psychic element.

Pregnancy is associated with a readjustment of endocrine function which is entirely physiological in normal pregnancy, but evidence is growing that the various disturbances classed as toxemias of pregnancy are essentially due to hormonal dysfunction. Progesterone or closely similar substances secreted by the placenta are under investigation.

These are representative of the disorders of endocrine functions which assume clinical importance. The extraordinary discoveries of suprarenal cortical function have opened a new field which has not yet been adequately explored, and there is strong evidence that other not yet discovered endocrine functions and disturbances thereof will prove important in the future. Reference has been made to renin as secreted by the kidney. The liver also has endocrine functions as yet not fully understood.

tissue and cause symptoms because of the amount of secretion which enters the body; thus hyperthyroidism may be caused by thyroid adenoma and hypoglycemia by adenoma of the islands of Langerhans. If unchecked, they may in their growth invade surrounding structures and thus cause symptoms. They may press upon nerves, esophagus, blood vessels, etc. Because of their encapsulation, their removal is relatively simple. Benign tumors are generally given names after the tissues in which they grow: osteoma from bone, myoma from muscle.

The cells of malignant tumors tend to change to become less differentiated than their parents This condition is called anaplasia. There are various degrees of malignancy, and generally anaplasia becomes more marked as malignancy increases. Malignant tumors do not remain encapsulated but infiltrate the tissues in which they grow and also the surrounding structures. Thus, it becomes very difficult to remove them. Sometimes benign tumors become malignant. It may then be seen how the malignant cells break the capsule and spread through surrounding tissues. When malignant tumors spread into lymphatics and blood vessels, cells may break off from the tumor mass and travel through these vessels to distant parts of the body where they will start new independent tumors. These are called metastases While they theoretically may occur anywhere, it is a clinical observation that certain tumors preferentially metastasize to certain tissues: prostate to the bones, stomach to the liver, teratoma to the lungs.

Malignant tumors fall into two great groups. Those originating in epithelial and glandular tissues are called carcinomas, and those which originate in connective tissue are called sarcomas. Generally speaking, carcinomas will develop later in life than will sarcomas, but there is no certain distinction between the two groups.

Malignant tumors grow and spread at varying rates. Some will remain localized for years; others will spread fast A malignant tumor generally consists of cellular elements and supportive fibrous tissue. In general, the more cellular tumors grow more rapidly, the more fibrous ones more slowly Also, malignant tumors tend to grow more slowly and metastasize later in older persons Most malignant are tumors which originate in active tissues such as a lactating breast or a pregnant uterus.

tumors which respond to this treatment and surgical operations. These methods are becoming so efficient that many are now saved who formerly would have perished.

The term neoplastic disease designates autonomous, progressive, unlimited new growth of cells, the primary cause of which is unknown.

Causes. In an attempt to elucidate the cause of neoplasms, two kinds of causes become probable: extrinsic factors which originate outside the body and intrinsic ones which originate within the body.

While many extrinsic factors have been suspected, very few have been proved true. It is certain that chronic irritation of certain cells may result in neoplastic change. The classical examples are the cases of cancers which developed in workers in tar, in areas where tar constantly comes in contact with the body, cancers of the mouth and lips which developed where there had been chronic irritation from a pipe or a ragged tooth; and skin cancers of the hands of persons who had been constantly exposed to x-rays. Other relationships have been suspected but not proved

Almost certainly an endogenous factor is essential. Just what this is remains unknown. All that can be said is that certain kinds of tumors tend to occur in families, though strict heredity has not been demonstrated, and certain neoplasms, especially cancers, develop in the later age brackets. It is not known whether this is because the "cancer factor" or the early stages of cancer develop so slowly that they take many years to become manifest or because the aging tissues acquire a peculiar quality which favors the development of cancer.

Thus, the fact remains, that under certain unknown circumstances certain cells of the body begin to grow out of bounds and after a while manifest themselves as abnormal masses, called tumors or neoplasms.

Classification.—Neoplasms fall largely into two classes: benign and malignant.

Benign tumors contain cells which retain the morphological characteristics of those of the parent tissue; they all remain in the place where the tumor first started and are frequently separated from the mother tissue by a capsule. In the case of endocrines, they may also retain the function of the mother

CHAPTER 11

DISEASES DUE TO PHYSICAL AND CHEMICAL AGENTS

PHYSICAL AGENTS

Introduction.—The human body is able to function within certain limits of temperature and barometric pressure and to sustain a certain amount of external violence However, when those limits are exceeded, adjustments or attempts at adjustments take place which may be considered "disease." Research of recent years has revealed that these changes are far more profound and affect the body economy much more extensively than was hitherto suspected. As soon as the stress from a physical agent reaches a certain intensity, the pituitary-cortical defense mechanism comes into play, and an excess of corticosteroids enters the circulation in an attempt to maintain normal functions It does so either until the emergency has passed or until the body defenses are exhausted and collapse. This explains the clinical observation that patients survive some stress for an indefinite period, apparently doing well, only to succumb suddenly and unexpectedly This may be seen, for instance, after traumatic injuries and after surgical operations.

Besides the general defense reaction, each kind of physical agent has its own characteristics by which it is set apart from the others

Cold.—Exposure to cold may be general or localized. General exposure to cold results first in general excitement, after which the exposed person becomes sleepy, passes into coma, and dies If he is rescued short of death, there follows a period of lowered resistance to infections and other stressors

Teratomata are of particular interest. These tumors arise from the germinal cells of the ovaries or testes and possess great powers of differentiation; in them will, therefore, be found such structures as hair, teeth, and glandular tissues.

As malignant tumors grow they manifest themselves by pressure on their surroundings or by destruction of neighboring tissues. The first evidence may be a tumor, either the original growth or a metastasis. In fact, often the metastases are discovered before the parent tumor. At other times the first evidence is bleeding from an eroded blood vessel; this often happens in cancer of the stomach or the renal pelvis. At other times pain results from pressure on nerves or bone, but frequently malignant neoplasms remain painless until quite late in their course. However, most of them cause pain before they kill. In some cases localizing evidence is late, and the patient simply loses strength and appetite and becomes anemic, and a thorough search is necessary to establish the diagnosis.

became victims of these mutilating and often fatal diseases because a latent period frequently will intervene before they become manifest, and it took some years before the danger of exposure was realized.

The *atomic bomb* is a powerful source of ionized radiation. "Death of some victims was immediate, due to shock. Others developed leukopenia and died of infections. Others exhibited a tendency to hemorrhage in various organs, not so much the result of destruction of thrombocytes but rather of an increased amount of heparin in the blood (Allen and Jacobsen). *Anemia was often profound. The effects of intense radiant* energy were principally upon the hematopoietic system, the lymphoid apparatus, the gonads, the hair follicles, the mucosa of intestines and the respiratory tract." (Karsner.)

Barometric Pressure.—The human body will function under a wide range of *barometric pressure*, especially if the transition is gradual. Rapid transition will cause symptoms. Two definite conditions are known: Caisson disease and altitude sickness.

Caisson disease. When divers who have worked in bells under high pressure have the pressure suddenly released and when aviators rapidly ascend to 30,000 feet or more, gases are released from the blood so rapidly that they do not get time *to be filtered through the lungs but form bubbles in the* circulation. These bubbles may act as emboli and cut off circulation from various areas. When this happens in the spinal cord, serious paralysis may result.

When *altitude* is attained more gradually, as when climbing mountains or flying about 10,000-20,000 feet altitude, the lowering of oxygen pressure manifests itself less dramatically, but *the patient will suffer from headache, vertigo, epistaxis,* vomiting, muscular weakness, and shortness of breath

Traumatic Injury.—Traumatic injury varies so greatly from case to case that generalizations are difficult. They may vary from pinching a fingernail in a door to a fatal blow on the head. They may be crushing, cutting, or straining, depending upon the nature of the violence. If bones are involved, they may be fractured, and blood vessels may rupture. Injury may be direct or indirect: A spleen or kidney may rupture from a severe blow to the body, cerebral concussion or meningeal

Local exposure to cold, generally of extremities, will result in chilblains in milder cases and in frostbite if the exposure is more severe. Severe frostbite leads to marked circulatory disturbances with edema and necrosis of the skin. The nerves also may become destroyed, and the whole limb may be lost.

Heat.—Exposure to heat also may be general or localized. Persons working under excessive heat and perspiring greatly suffer from the loss of salt and water. If they quench their thirst by drinking water alone, the body is gradually deprived of salt. This may cause cramps of the muscles of the extremities and of the abdominal wall.

Climatic heat, especially if it is humid, may lead to heat exhaustion with weakness, stupor, dizziness, suppression of urine, and fever. Excessive heat may also lead to "heat stroke" *which is acute failure of the heat-regulatory mechanism.* The patient suddenly becomes unconscious with high temperature (for example, 109 ° F.). This condition may be rapidly fatal.

Local exposure to heat results in burns. The damage to the tissues varies with the intensity of the heat, from simple reddening of the skin, as following exposure to sunshine, to complete destruction of tissue. Blisters form an intermediate stage. If the burn is extensive, shock with fall in blood pressure and hemoconcentration may follow. Burns may be followed by gastric or duodenal ulcers (Curling's ulcers) or by kidney damage, both of which have been explained as being due to failure of adaptation to the stress of the burn.

Ionized Radiation.—Ionized radiation from x-rays, radium, or other atomic energy results in profound changes if given in sufficient doses. Clinically there is general discomfort with nausea and vomiting (radiation sickness). If radiation has been intense, there may be marked degenerative changes in the exposed tissues. The blood-forming organs, the gastrointestinal tract (including the liver), and the gonads are especially sensitive. Persons who work with radioactive materials without adequate protection may develop skin lesions of the exposed parts. These vary from simple erythema to destruction and complete necrosis of the parts. As the skin cells degenerate they may become malignant, and skin cancers are an important complication. Many of the early x-ray workers

tion and the central nervous system, causing mental and physical incoordination, deepening into coma, and occasionally death.

Miscellaneous Poisons.—Other poisons are valuable medicinal remedies in small doses and become toxic only when these are exceeded. The barbiturates, opiates, and inhalation anesthetics affect the central nervous system. In moderate doses they are sedative and induce sleep or anesthesia, but in excessive doses they produce coma which may be fatal. Carbon monoxide is a gas which attaches itself to the red cells of the blood in place of oxygen, thus causing "internal suffocation"; the blood to the tissues carries insufficient oxygen, and the patient succumbs to tissue anoxemia. Other poisons have special affinity for other organs. Phosphorus and carbon tetrachloride will destroy the liver more than they will affect other organs. Heavy metals affect the cells of the renal tubules; the resulting clinical picture is nephritis or nephrosis. The heavy metals of greatest importance are lead, mercury, and bismuth. Lead is an important industrial poison. It is an ingredient of paints, and formerly lead was used for water pipes and drinking vessels. Lead causes gastrointestinal disturbances and anemia with blood dyscrasias ("stippling of red cells"). Mercury and bismuth were important drugs in the treatment of syphilis before the advent of penicillin Snake venom will paralyze nerves or hemolyze the red cells.

Corrosive Poisons.—The corrosive poisons destroy any tissue with which they come in contact When swallowed, they cause violent gastrointestinal disturbances with vomiting and bleeding from the gastrointestinal wall When they are absorbed, their principal effect is upon the hydrogen ion concentration of the blood and tissue fluids. This is maintained within narrow limits by a very delicate mechanism. In poisoning of this kind this mechanism may be strained to the limit, but if the alkalinity or acidity of the blood exceeds certain limits, life cannot be sustained

Thus, the clinical picture of poisoning is large and varied, but it is relatively unimportant, for excepting the receiving ward of a large general hospital, the number of "poison cases" is small compared with other diseases.

hemorrhage may result from a blow on the head. Injury will, therefore, result in local changes, pain, swelling, or destruction of tissue, and in more general changes resulting from shock or hemorrhage.

The changes resulting from shock which have previously been discussed are part of the general adaptation syndrome, and they may, as elsewhere, follow a period of apparent well-being.

Hemorrhage results in various clinical conditions, depending upon the amount of blood which is lost and the rate at which it is lost. *Sudden massive hemorrhage* will result in pallor, weakness, and shortness of breath, soon developing into faintness, unconsciousness and collapse, which may be fatal unless the hemorrhage is controlled. When blood is lost slowly, the body may gradually adjust itself to a lowered state of hemoglobin and symptoms will be delayed. Eventually the patient will develop pallor, fatigue, dyspnea on effort, and dependent edema. A gradual loss of blood is borne much better than a sudden one.

CHEMICAL AGENTS—POISONS

Introduction.—Many substances do no harm to the body unless they are absorbed from the intestinal canal or the skin in sufficient amounts. They will then cause disturbance of various physiological functions and may be fatal. Such substances are called poisons. Some others will destroy human tissues on contact, both the surface and the gastroinestinal canal if they are swallowed. In that case they will also be absorbed and seriously disturb the homeostasis of the body. These substances are called *corrosive poisons*. They are, generally, strong acids or alkalies. While corrosive poisons have in common the quality which gives them their name, they have also certain specific effects and, of course, the treatment which they require may vary.

A general survey such as the present cannot discuss poisons in detail but must limit itself to a few representative examples.

Alcohol.—Alcohol is probably the most commonly used poison. In small amounts it is relaxing and removes inhibitions, especially social restraints. It is, therefore, frequently used for social purposes. In greater amounts it disturbs diges-

as palpitation, blushing, or diarrhea occasioned by some passing emotional experience such as fear, embarrassment or tension over an examination, or stage fright. It might be more chronic in nature such as aggravation of chronic colitis or of rheumatoid arthritis in a person who is constantly harassed by economic difficulties or worried over a close relative at war. However, it is not always so simple. Sometimes the relationship is remote, not even apparent to the patient. There might be an emotional conflict within him which he would not relate to his somatic symptoms and which would defy a simple solution.

The conflict might be between personal desire and religious considerations, or it might be a conflict between parental and patriotic feelings, such as a mother might feel when sending her son off to war. Again the relationship might be even more remote and require a searching analysis into the patient's past life and emotional experiences.

Stress.—It is necessary for everyone who works with sick people to appreciate the personal or emotional aspect of the disease. It is almost always present whether or not it dominates the clinical picture. In the past, whenever it became marked, it was always thought to be primarily the concern of the psychiatrist. The whole problem has changed somewhat now since we realize the close relationship between the thalamic and hypothalamic centers and the pituitary-cortical axis We know that these brain centers govern emotions and that they are closely related to the pituitary. We also know that certain emotional stress is immediately transmitted through this system and will find clinical expression in hypertension, tachycardia, etc If we apply these known facts to other conditions less readily understood, we have a tangible mechanism through which psychosomatic manifestations may find expression.

However, this mechanism may work also the other way There is evidence that the cortical response to stimuli is abnormal in some persons with abnormal psychic reactions Some mental conditions, such as dementia praecox and manic-depressive psychoses, have been treated with "shock therapy"; that is, the patients have been submitted to a severe electric shock, or they have been given insulin in sufficient doses to produce convulsions from hypoglycemia. The patients have

CHAPTER 12

PSYCHOSOMATIC DISEASES

Introduction.—It has long been recognized that certain psychic states could find expression in symptoms ascribed to definite organs or even in disturbance of function of these organs.

Patients who were under nervous or emotional strain would develop "palpitation" or pain in the chest resembling angina pectoris. They might develop abdominal pain or headache. These symptoms would be as real to the patients as those caused by organic heart disease, and yet a most thorough examination by all existing methods would fail to reveal any change which would satisfactorily explain the symptoms.

In another group of cases there would be disturbance of function over which the patient apparently had no control. The palpitation might be due to extrasystoles or to paroxysmal tachycardia. There might be diarrhea and vomiting, or x-ray examination would reveal spasm of the colon, or the patient would develop colitis even of the ulcerative type. It was possible to establish a definite relationship between nervous strain and the development of peptic ulcer. Patients with rheumatic diseases, both rheumatic fever and rheumatoid arthritis, would do better when they were kept in quiet congenial surroundings than when they were nervous and upset. Hypertension and angina pectoris were outstanding examples of conditions which would become worse under nervous strain and improve under rest and relaxation. The emotional element in most allergic conditions was also obvious.

Psychosomatic Medicine.—Thus a close relationship between emotional states and many diseases was well recognized, even to the point of establishing a new "specialty"—"psychosomatic medicine." It might find expression in simple episodes such

It still remains necessary to have some working system whereby to classify diseases, and this unit has suggested that the following may be useful: congenital diseases, disturbances of nutrition, diseases caused by parasites and microorganisms, diseases of the mesenchyme, diseases of the vascular system, disturbances of internal secretion, neoplastic diseases, diseases due to physical and chemical agents, and psychosomatic diseases. This classification is not perfect or final, for there are some conditions, such as certain nervous disorders, for which it may not provide, and it does allow for some overlapping, for endocrine disturbances are involved in infections and so on. Nevertheless, it does provide a starting point from which to consider the causes of diseases. When it comes to the practical approach to the study of diseases, it may be well to consider at least some of them from a more systematic viewpoint, such as diseases of the gastrointestinal tract, diseases of the skin, etc. Whatever classification is used, however, does not invalidate the fact that the important thing to know about each disease is its essential nature, the manner in which the body meets its challenge, and consequently its clinical manifestations, all of which determine the treatment and the ultimate goal of relieving suffering.

STUDY QUESTIONS—UNIT II

1. Define all the terms used in the classification of disease on p. 51.
2. Why is a classification of disease "according to cause" not completely satisfactory?
3. Name congenital diseases of the nervous, the cardiovascular, the gastrointestinal, and the genitourinary systems
4. What do you understand by the *defenses of the body*?
5. Discuss the *general adaptation syndrome*
6. What are *adrenergic substances*? How do they act?
7. Describe the functions of the adrenal and pituitary hormones.
8. Describe some of the more common diseases of adaptation
9. Why are vitamins necessary?
10. Discuss the effects of cold, heat, ionized radiation, the atomic bomb, altitude, hemorrhage, alcohol, and corrosive poisons on the body.

often improved following such treatment, though it has not always been understood why. Now we know that convulsions act as a form of stress which activates the pituitary-cortical system and presumably makes the patient secrete an increased amount of corticoids, following which he improves. Thus there is some relationship between corticoids and the mental states. It is, however, not a simple relationship, for improvement does not necessarily follow shock treatment or the administration of corticoids. More research is obviously needed before this matter is fully understood.

CONCLUSION TO UNIT II

In this unit an effort has been made to list some of the more important principles of the processes which cause disease. It was noted that the transition between health and disease is a rather gradual one and that diseases have in common certain features which help to classify them but which also indicate that diseases cannot be sharply divided into hard and fast classes and groups. Classification is a working tool of the pathologist or the clinician, and classifications which at one time seem reasonable and practical may have to be changed in the light of advancing knowledge.

Nevertheless, the study of the causes of diseases is most important and must go on, for it is only through a proper understanding of the cause of a disease that it will be possible to attack it in a rational way and cure, or, better still, prevent it. We have also seen that the study of the causes of disease requires as a corollary an understanding of the defenses of the body against that disease, for essentially a disease is a struggle between factors which threaten to disturb the physiological function and anatomical structure of the body and factors which strive to preserve the normal state or homeostasis.

Modern research seems to suggest that certain fundamental changes are part of the defense reaction to most diseases and that the "clinical pictures" are determined by the nature of the disease-causing factor and by the susceptibility of the individual organs. It is possible that many diseases which at present appear to be quite different will some time prove to be various forms of the same process. Medicine is likely to undergo great changes in the future.

UNIT III

PATHOLOGY—HOW DISEASE MANIFESTS ITSELF IN THE BODY

The student must approach this unit with the necessary knowledge of anatomy, physiology, and chemistry. From the field of nursing arts she should use the knowledge of the responsibility of the nurse in the observation of the patient and the reporting and charting of signs and symptoms. All of the new terms used in this complicated field must be mastered. As in the other units, the material here presented can only be understood if reference is constantly made to the background material mentioned above.

CHAPTER 13

SYMPTOMS

Introduction.—Disease produces symptoms and signs. A symptom is evidence of disease or change in normal body function which is apparent to the patient. A sign is evidence of disease found by the physician on physical examination. These two terms sometimes overlap—fever may be felt by the patient as abnormal warmth and demonstrated by the doctor and nurse with the thermometer. It is important for us to remember that symptoms and signs are the signals of disease and may have various interpretations.

Pain.—Pain is the most common symptom. Frequently it is the only symptom of which the patient complains, and that

11. Describe briefly the effect of parasites on the body.
12. Define: virus, bacteria, spirochetes, protozoa, immunity, opsonin, antibody.
13. What is meant by the "mesenchymatous diseases"?
14. Describe the mechanism of the allergic diseases.
15. What are the most common diseases of the cardiovascular and endocrine systems? What causes them?
16. What causes neoplasms? How may they be classified?
17. What is meant by the psychosomatic diseases? Describe some common types.

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localized over the affected part and is frequently aggravated by coughing or respiration. Heart pain is usually located behind the sternum or over the precordium. Genitourinary pain may be referred to the back or to the groins, suprapubic region, or genitalia. Disease of the nerves causes localized pain or pain at a distant point on the body, depending upon the sensory nerve pathways.

In order to survey the field of symptoms, it may be well to relate them to the various systems of the body, for often a disease affects a system or a part of a system. At other times the disease is regional, and symptoms arise from the various systems or organs which happen to be involved.

THE CENTRAL NERVOUS SYSTEM

Disturbance of the nervous system can be divided into functional, organic, and mental disorders.

Functional Disorders.—Functional disorders give rise to symptoms which are inconsistent and varied. They vary from time to time and are, generally, not followed by the kind of complications which follow symptoms arising from organic causes. For example, hysterical paralysis of an arm or limb rarely shows atrophy; hysterical vomiting, unless prolonged and severe, does not result in loss of weight

Organic Disorders.—Symptoms arising from organic diseases of the central nervous system are.

1. Vascular diseases of the brain—Headache is the most common complaint, particularly in hypertension and syphilis. The rupture of a congenital aneurysm causes headache which is severe and excruciating During the early stages of their diseases, the syphilitic, hypertensive, and arteriosclerotic patients complain of dizziness, difficulty in going to sleep, loss of memory for recent events, and irritability Sudden sharp pain in the head accompanied by stiffness of the neck occurs with emboli and subarachnoid hemorrhage. Weakness of a limb *or whole side of the body is due to destruction of nerve* pathways or hemorrhage

2. The various forms of meningitis (epidemic-spotted fever), pyogenic (streptococcal) or tuberculous, cause symptoms which are fairly *similar In general, headache, neck rigidity,*

alone brings him to the doctor seeking relief. The characteristics of pain vary greatly. Some patients feel pain even though no organic disease is present or cause is known. This is known as functional pain, and it is real to the patient. To complain of pain that is not felt, in order to gain some material advantage, is known as *malingering*.

Characteristics of Pain: For pain to be felt, an adequate stimulus is necessary. The minimal stimulus which produces pain is called the "threshold value." Some persons are more sensitive to pain than are others, that is, their threshold value varies, and what may be felt as a dull ache in one becomes an excruciating pain in another. Pain may be intermittent (wax and wane), short or long in its duration. It can last for seconds, hours, or days and then disappear to reappear months later. Pain may end suddenly or subside gradually. Relief from pain is sometimes obtained by keeping the afflicted parts at rest; for example, semiflexion of the knees in acute abdominal pain from appendicitis and complete rest from movement of painful joints or fractured limbs may bring relief from pain. Pain usually indicates the site of disease, and the patient focuses his attention on the involved area. However, it is important to know that pain felt in one place can have its origin elsewhere. This is known as referred pain. For example, the pain of heart disease (angina pectoris) may be felt in the left arm Pain may be related to simple routine acts such as eating, defecation, and effort. Patients often use quite striking terms in describing their pain. "colicky pain" in gall bladder disease, "boring pain" in metastatic cancer of the bones, "gnawing pain" in peptic ulcer, and "stablike" pain in heart disease

Often pain is our best friend, for it is the signal of disease. It attracts our attention and forces us to attend to a disturbance of our body before the damage becomes extensive.

Disease of the head and neck usually produces pain in those same organs, although it may be referred elsewhere. Pain arising from the esophagus is felt behind the sternum. Diseases of the stomach and duodenum produce epigastric pain. Pain caused by abnormalities of the small intestine is felt most often at the umbilicus or midline of the abdomen; that of the large intestine in the lower one-third of the abdomen without definite location. Pain of the respiratory system is

tumors. Emotional disturbance is frequent. Convulsions occur most often in tumors of the motor area.

Tumors of the frontal lobe produce general vague symptoms of emotional and psychic imbalance.

Tumors of the occipital lobe produce visual disturbances such as sudden flashes of light.

Temporal lobe tumors cause disturbances in the sense of smell, taste, and hearing.

Gliomata and meningiomata are the most common types of tumors of the spinal cord. Tumors of the cervical region affect structures innervated by nerves passing through the affected level, and the disturbances may be sensory, motor, and vascular paralysis. Spinal tumors of lower levels affect the function of abdominal and pelvic viscera and the lower extremities.

4. Traumatic symptoms arise from cerebral concussion, skull fracture, and subdural and epidural hemorrhage. With concussion there is loss of consciousness or dazed feeling which may be momentary or lost for hours or days. Skull fracture or hemorrhage also produces loss of consciousness, and the differential diagnosis rests upon the signs elicited by physical examination. *Headache and vertigo persist for* several days but eventually disappear. Stiff neck and mental disturbances may be associated with severe skull injury or brain damage.

Injuries to the spinal cord cause immediate sensory and motor paralysis below the level of the lesion Urinary incontinence is common.

5. Intoxications and deficiencies—Toxic agents may be bacterial and chemical.

Bacterial toxins affecting the nervous system give rise to headache, vomiting, sensitivity of the eyes to light (photophobia), delirium, and stupor. These symptoms may be seen, for example, in acute lobar pneumonia.

The toxins of tetanus and diphtheria produce symptoms arising from the effects of those toxins upon certain parts of the nervous system. The onset of tetanus is characterized by stiffness of the muscles of the jaws and neck. The jaws may be tightly closed (lockjaw). In diphtheria, paralysis of the palate *may occur*, causing "nasal" speech *and difficulty in* swallowing.

and fever are present. Dizziness, nausea, vomiting, and stupor are common but vary in frequency. Less common are visual disturbances (photophobia) and convulsions.

The onset of the symptoms is usually sudden except in tuberculous meningitis, which has a gradual onset; however, in children the onset may be abrupt.

Encephalitis of syphilitic origin causes nervousness, headache, and paresthesias. In general paresis there is disturbance in ethical sense and judgment, impaired memory, and carelessness about dress and manners. In tabes dorsalis the patient complains of various pains and paresthesias which may affect any part of the body. Epidemic encephalitis causes double vision, headache, insomnia, and some neck rigidity.

In myelitis the prodromal symptoms of anterior poliomyelitis are vague. The most common complaints are backache and pain in the head and neck. Early symptoms of "lack of pep," "stuffy head," and stomachache are frequent. Children become fretful and refuse to eat. Occasionally the first symptom is weakness of one leg. Symptoms of Sydenham's chorea appear slowly: The movements of the extremities become jerky and awkward, and this increases with excitement Facial grimacing is common. The gait is "dancing"—the patient whirls around and runs forward in a sort of rhythmical movement.

Abscess of the brain caused by pyogenic bacteria or syphilitic gumma produces severe headache, loss of weight, fever, and drowsiness If the cerebellum is involved, dizziness occurs. Depending upon its location, abscess may produce sudden weakness of one side and convulsions.

3. Tumors—Symptoms are general, resulting from increased intracranial pressure, and focal, resulting from the effects of the growth on the surrounding structures General symptoms are headache, dizziness, vomiting, and convulsions. The focal symptoms are much more varied and may be disturbance of almost any function with which the brain is concerned. Symptoms depend upon the location of the neoplasm in the brain and spinal cord Tumors in the cerebral hemisphere (glioma) give rise to symptoms of headache which is well localized, constant, or intermittent in character. Vomiting is almost as common as headache and may be projectile. Vertigo is less common and is usually found with cerebellar

6. In congenital disturbances such as Huntington's chorea, cerebral diplegia, Friedreich's ataxia, and progressive muscular dystrophy, there are difficulty in walking and muscular weakness. In some of these conditions there are mental disturbances, but often the intellect is unaffected.

7. Unknown etiology—Symptoms of multiple sclerosis are protean in nature. Retention and incontinence of urine is common. Paresthesia, anesthesia, and hyperesthesia are present in various degrees. Patients with syringomyelia complain of frequent injury without pain or the sensation of heat (cigarette smokers burn their fingers). Migraine headache is characterized by periodic severe one-sided headache preceded by the feeling of malaise. Epileptic symptoms are of two types, the grand mal or major attack, in which the patient becomes entirely unconscious and has convulsions, and the petit mal or minor attack, *in which the patient's mind is momentarily* blank.

Mental Disorders.—Symptoms are produced by three types of mental diseases: (1) psychoses or functional disorders; (2) organic psychoses of known etiology, (3) psychoneuroses —*neurotic syndromes.*

1. Psychoses are functional disorders producing emotional disturbances. There are many kinds of psychoses, only a few can be mentioned here. The manic-depressive generally complains of feeling unhappy He has periods of abnormal sadness alternating with happiness. Schizophrenics, who comprise the majority of mental disorders, have symptoms of several types: hebephrenic (meaningless laughing and smiling), catatonic (bizarre postures of the limbs and body), paranoid (delusions of persecution associated with daydreaming and an imaginative life of fantasy), and the simple type *(listlessness and gradual slowing down of the mental* processes)

The paranoid patient complains that his friends and neighbors are scheming against him (persecution complex)

2. Psychoses occurring with organic disease of the brain—In far-advanced arteriosclerosis the following symptoms appear: headache, dizziness, decrease of memory for recent events, frequent unsuppressed episodes of crying and laughing. Encephalitic symptoms vary in the acute and chronic stage and with the age of the patient. The most common symptom

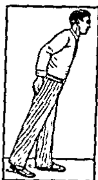


Tabetic Gait





Steppage Gait
Multiple Neuritis



Paraplegic Gait



Hemiplegic Gait



Gait of
Paralysis Agitans



Gait of
Cerebellar Ataxia

Fig. 20.—Examination of the nervous system—gaits. (From Clendening and Hashinger: Methods of Diagnosis, The C. V. Mosby Co.)

Patients frequently complain of poor vision: Difficulty in reading small print unless it is held close to the eyes is called nearsightedness (myopia); necessity of holding small print at a greater than normal distance is called farsightedness (hypermetropia). Inflammation of the cornea produces lacrimation, pain, and the scratchy sensation of a foreign body in the eye. Difficulty of vision is produced by many conditions, including optic nerve atrophy, glaucoma, iritis, corneal opacities (cataract), tumors, and disturbances of the retina.

Ears: Furunculosis (boil) produces pain on movement of the ear lobe. Sensation of fullness or partial deafness occurs with impacted cerumen (wax). Sudden temporary pain with decrease in hearing and ringing in the ears occurs with rupture of the eardrum. The outstanding symptoms of infection of the eustachian tube are feeling of fullness and partial deafness in the affected ear. Middle ear infections (otitis media) produce throbbing earache and fever. Mastoiditis produces fever and pain over the mastoid process.

Ménière's disease and acute labyrinthitis have similar symptoms of sudden deafness, nausea, vomiting, tinnitus, and disturbance of equilibrium.

Nasopharynx and Mouth: Lacrimation and aching of the eyes, fullness of the nose, nasal discharge, and dull frontal headache are the principal symptoms of coryza (head cold), the most common affection of the nasopharynx. Increased salivation *is associated with abdominal pain, psychic disturbances*, early nausea, diseases of the brain, infections of the tongue, salivary glands, and buccal mucosa, and drug intoxications (mercury). Pain in the nasopharynx and mouth originates from local disturbances as infected teeth, infections of the gums, injury, and tumors. Difficulty in swallowing (dysphagia) due to obstruction, spasm, or improperly coordinated muscular function and pain on swallowing occur in disease of the throat and esophagus.

Neck.—The important symptoms are pain, swelling, and disturbance in movement and stiffness They arise from numerous causes such as spasm of the neck muscles from myositis, abscesses, enlarged lymph nodes (leukemia, Hodgkin's disease, tuberculous glands), trauma, congenital anomalies (branchial cyst), tumor (cancer), and infections (mumps).

in children is the complete reversal of a well-behaved child to disobedience, stealing, and lying. Brain tumors or injuries give rise to symptoms depending on the area of brain involved. Frontal lobe tumors or injuries reveal themselves through abnormal depression and euphoria, headache, or difficulty in concentration.

3. Psychoneuroses—The syndrome of psychoneurosis consists of evidences of disturbed personality that appear when an individual is confronted with some disagreeable problem There may be fear (phobia), for example, of altitude, abnormal worry (anxiety), paralysis and blindness (hysteria), awareness of normal body changes which are thought to be abnormal, such as the gurgling noises made by the normal bowel (hypochrondriasis).

THE HEAD AND NECK

Head.—Headache is one of the most common of symptoms. It presents many varieties. The headache of eyestrain is a dull, aching discomfort felt in the frontal, temporal, or occipital regions. It appears late in the afternoon following prolonged use of the eyes for reading, movies, or delicate mechanical work. Headache from sinusitis has more of a dull, deep, aching character; it is more severe in the morning, becoming less toward late afternoon. Frontal sinusitis headache is located over the frontal bones, sphenoid sinusitis headache in the occipital region, and maxillary sinusitis headache below the eyes. Muscular strain of the neck muscles from excessive exercise and cervical arthritis give rise to occipital-cervical headaches, worse on awakening in the morning, and relieved by exercise or massage Migraine is a well-localized, unilateral headache varying in intensity from a throbbing or pounding to intense pain. It is frequently associated with nausea and vomiting. Headache from brain tumors is diffuse—mild at first but gradually increasing in severity The so-called nervous headache, which follows emotional upset, is generalized or may be localized to the temples

Eyes: Burning or smarting, increased lacrimation, and itching characterize conjunctivitis. Photophobia (sensitivity to light), associated with conjunctivitis and fever, is seen in measles. Pain and conjunctivitis are common in iritis.

10. **Vagus:** Because this nerve innervates a vast part of the body, disturbances of its functions are many and varied. They include hoarseness, nasal speech, and loss of voice. Disturbances of the thoracic division slow the heart, while below the diaphragm it acts as an accelerator of the stomach and intestinal tract.

11. ***Spinal Accessory:*** *Disturbance of this nerve produces* weakness of the trapezius and sternocleidomastoid muscles which control the elevation of the shoulder and rotation of the neck.

12. **Hypoglossal:** Loss of function of this nerve causes the tongue to deviate to the affected side because of weakness of the paralyzed muscles in that side of the tongue.

THE RESPIRATORY SYSTEM

Cough.—Cough is a forceful expiration, used to remove secretions *and foreign body material from the larynx, pharynx,* and trachea. It is generally released by reflex action. It is a protective mechanism of the lungs. It may occur in most diseases of the respiratory tract but may occasionally be mild or entirely absent. The expectorated material may be dust that has been inhaled and has caused irritation of the mucosa and increased secretion or food that has become lodged in the glottis instead of passing into the esophagus Normally cough is absent in healthy individuals, since secretions are minimal. Some individuals cough from habit to attract attention Secretions or exudates in the deep air passages do not produce *cough until they reach the bronchi. Infections of* the air passages produce cough associated with expectoration. A dry hacking cough with minimal secretion accompanies the early stages of laryngeal inflammation, tracheitis, bronchitis, and pneumonia. This cough usually lasts only a few days; then it becomes productive A persistent benign, dry cough is found in people who are heavy smokers (cigarette cough) or live in areas of dusty contaminated atmosphere, as in some large cities Tuberculosis may begin with a similar type of cough Persistent cough is a symptom of various serious diseases, such as pulmonary tuberculosis or cancer of the lung

A productive cough results in sputum Patients with mild bronchitis have a dry cough during the day, but during the

Cranial Nerves.—

1. Olfactory: This nerve has two functions—smell and taste. Loss of smell may be temporary from severe head injury or allergy, or permanent from a tumor involving the olfactory nerve. This nerve is necessary for taste of foods. Injury or tumor will cause loss of taste for spices and meats and flavored liquids but not for the perception of salt, bitter, or sweet.

2. Optic: Disturbances of vision are so important, so numerous, and different that they have necessitated the development of a whole [illegible] (ophthalmology). Vi[illegible] the optic nerve itself [illegible] glaucoma, and brain tumors) and also disturbances of the structures in the eyeball (for example, injury, errors of refraction, inflammations, etc.). They are, principally, complete absence of vision, distortion of the visionary image, and disturbance of color perception.

3. Oculomotor; 4. Trochlear; 5. Abducens: These nerves control ocular movements which may be disturbed by lesions both in the brain and along the course of the nerves. They may be congenitally unbalanced and thus cause strabismus (squinting).

6. Trigeminal: Disturbance of this nerve is manifested by loss of superficial sensation of the face and scalp. The pain of trigeminal neuralgia (tic douloureux) is felt over the areas of the face supplied by the first and second divisions of the nerve. The motor division when diseased produces weakness or paralysis of the muscles of mastication (chewing), which are the masseter and temporal muscles.

7. Facial: Inability to close one eye, drooping of the angle of the mouth, difficulty in talking or whistling characterize seventh nerve peripheral or nuclear paralysis.

8. The eighth nerve has two divisions. **cochlear** (auditory) *and vestibular (concerned with equilibrium). The cochlear* division is associated with symptoms of nerve deafness and *tinnitus.* Disorders of the vestibular division cause vertigo and short, rapid involuntary movement of the eyeballs—horizontal, rotary, or vertical (nystagmus).

9. Glossopharyngeal: Glossopharyngeal neuralgia is pain starting on the side of the throat and radiating to the side of the face or neck.

exercise in order to increase the amount of air available for gaseous exchange. In some diseases hyperpnea results from less than normal exertion. This is called dyspnea. Dyspnea so severe that the patient cannot breathe comfortably lying down but has to sit up to breathe is called orthopnea. With infections of the lungs there is usually an increase in the rate of breathing (polypnea). Polypnea almost always accompanies dyspnea and hyperpnea.

Diseases of the respiratory tract such as asthma, obstruction of the larynx, trachea, or bronchus, tuberculosis, emphysema, and pneumothorax will produce difficulty in breathing.

Pain.—Pain arising from the respiratory system usually indicates disease of the pleura. Disease of the lungs can exist without pain. The visceral pleura that surrounds the lung does not contain nerve endings. Therefore, it is not sensitive and cannot cause pain. The parietal pleura, which lines the chest wall, does contain nerve endings and is sensitive. Pleuritic pain is localized over the involved pleura; it is sharp, stabbing, or knifelike and is aggravated by cough or deep inspiration. It is more common in the lower thorax than in the apical area. Although pain is associated with infections of the larynx, trachea, and bronchi, it is usually due to disease of the pleura.

Fever.—Fever accompanies most infections at one time or another if they reach a certain degree of severity Patients complain of feeling abnormally warm or flushed. Mild laryngitis, tracheitis, and bronchitis are usually not associated with fever. Some lung infections, such as lobar pneumonia, have a sudden onset of high fever. Low-grade fever is common in bronchiectasis and pulmonary tuberculosis.

Normally, following meals, the temperature is slightly elevated for a short time and then returns to normal.

Chills.—A chill is sensation of cold with shivering accompanied by an elevation of temperature of the interior of the body while the surface may remain cool. Chills may be caused by excessive joy or fear, exposure to cold, and emotional upset A chill may be the first symptom of an infection.

Night Sweats.—Excessive sweating at night, sufficient to drench the bedclothes, occurs with pulmonary tuberculosis and debilitating diseases such as bronchiectasis.

night secretions accumulate and an episode of coughing occurs in the morning to bring up the material. Severe paroxysms of coughing which end in vomiting occur with severe infections. Some patients bring up large amounts of foul sputum in the morning. This occurs with bronchiectasis. Sputum may be frothy as is seen in edema of the lungs and in congestive heart failure. Cough produced by a paralyzed vocal cord is *brassy in character. Emphysema produces a muffled* cough.

Expectoration.—The quantity of sputum varies in different *conditions. Sputum consists of pus, mucus, and occasionally* serum. Mucoid sputum is colorless and thick as found in chronic smokers. Purulent sputum is greenish-yellow and thick. Serous sputum is colorless and thin. Various combinations may exist such as mucopurulent sputum of bronchitis. *Sputum mixed with blood has a brownish or pink tinge;* for example, in pneumonia and congestive heart failure. *Tuberculous sputum is mucopurulent, containing greenish-*yellow particles. If hemorrhage has occurred, the sputum may be *streaked with bright red frothy blood or consist entirely* of blood. The sputum of bronchiectasis is very abundant and mucopurulent. Diseases causing hemoptysis (spitting up of blood) are pulmonary tuberculosis, pneumonias of all types, bronchiectasis, malignant tumors, and pulmonary infarction. Hemoptysis from no obvious cause must be considered as being tuberculous in origin until proved otherwise.

Some patients *complain of the foul odor of their sputum.* A foul, putrid odor is associated with lung abscess and lung gangrene.

Dyspnea.—*Dyspnea is the conscious sensation of shortness* of breath or difficulty in breathing. It is the most common symptom of serious pulmonary disease. *It is the result of a* decrease in the volume of lung tissue available for breathing. The small air sacs of the lung (alveoli) for some reason do not allow for the normal exchange of gases (oxygen and carbon dioxide) between the lungs and the blood. The oxygen content of the blood decreases and the carbon dioxide content increases. When the oxygen content of the blood becomes too low, *there* results an increase in the depth of breathing (hyperpnea). Hyperpnea also occurs normally during severe

cate severe cardiac disease. Any change from the usual normal rhythm or rate may make an individual aware of his heart. Some of the important diseases of which palpitation is a symptom are heart block, auricular fibrillation, and auricular flutter. The most common cause of palpitation is extrasystoles, which, in themselves, are not important Most commonly palpitation results from alcohol, coffee, fatigue, excitement, exertion, thyrotoxicosis, and cardiac arrhythmias (premature beats and paroxysmal tachycardia). Palpitation is common when the heart is enlarged and lies close to the chest wall. Some persons complain of palpitation when they lie on their left side This places the apex of the heart nearer the chest wall.

Pain.—Cardiac pain is thought to be caused by (1) accumulation of metabolic waste products in the heart muscle or (2) lack of oxygen (anoxemia). Pain is not necessarily a symptom of heart failure.

The pain of angina pectoris may be sudden and knifelike and substernal. It may occur following exercise, excitement, or a heavy meal. The pain may last a few seconds to thirty minutes; usually it lasts a few minutes It is often accompanied by a feeling of suffocation. When the pain becomes severe, the patient usually ceases all activity, after which it subsides. Frequently the pain radiates into the neck or down the inside of the left arm.

The pain of coronary thrombosis is substernal, more severe, and lasts longer than the pain of angina pectoris Short stabs of pain or heartache characterize irregularities of cardiac rhythm. In cardiac neuroses, the patient is conscious of the normal heart functions and imagines that they are symptoms of heart disease.

Patients with rheumatic myocarditis or acute pericarditis feel a dull or sometimes sharp precordial pain.

Dyspnea.—Shortness of breath is an important symptom of heart disease. Frequently, it is the first evidence that the heart is failing Other diseases within the chest, associated with a heart of normal size and producing dyspnea, are aortic aneurysm, pulmonary tuberculosis, carcinoma of the lung, and pneumonia.

Fatigue, Malaise, Prostration.—Fatigue is a normal state of weariness that follows exertion. Diseases may debilitate the body to a point where fatigue is produced by much less than the usual amount of effort. Malaise means feeling out of sorts. These two symptoms may be the first indication of disease. Prostration is a marked loss of strength producing severe exhaustion which requires immediate rest to prevent collapse.

THE CARDIOVASCULAR SYSTEM

Introduction.—Before discussing symptoms of heart disease, we should know something about the different forms of heart disease.

A common disturbance of the heart is caused by deformation of the heart valves. This allows for incomplete closure of the valves, permitting a backflow of blood (regurgitation), or too narrow an opening (stenosis), inhibiting the free flow of blood. Syphilis and rheumatic fever may cause this. The heart muscle may remain healthy and only the heart valves be diseased. When this happens, the blood fails to circulate normally and progressive heart disease may follow.

There may be injury to the heart muscle without involvement of heart valves. This may result from a poor blood supply to the heart muscle, as in coronary artery disease, or toxins may damage the muscle, as in diphtheria.

The sac that surrounds the heart (pericardium) may be diseased. Circulation of the blood is disturbed by pressure on the heart when the pericardium is inflamed (pericarditis)

Congenital anomalies are rare The heart muscle is usually normal, but the heart valves and chambers or large blood vessels show abnormal development

Disturbance of the mechanism of the heartbeat is common. An example is a sudden abnormal increase in the heart rate (paroxysmal tachycardia).

Some patients complain of cardiac symptoms without demonstrable organic cause. This disorder is called functional heart disease or cardiac neurosis

Palpitation.—Palpitation or throbbing is a forceful beat of the heart perceptible to the patient It may or may not indi-

tural arterial disease. Sudden pain in an extremity indicates *arterial occlusion by a thrombus or embolus.* Temporary coldness of the extremities may be normal, but persistent coldness is abnormal.

Raynaud's disease, which mostly affects young women, involves the blood vessels of the toes and fingers. Excitement and fatigue produce vasoconstriction with resulting change in color (blueness or cyanosis), coldness, numbness, and pain in the digits

Buerger's disease causes occlusion of the arteries and is characterized by coldness of one or both lower extremities and intermittent claudication.

Generalized inflammation of the small arteries (periarteritis nodosa) produces fever, sweating, malaise, muscular weakness, and abdominal pain

Thrombosis or embolism blocks the flow of blood through the involved vessel. The onset is sudden with severe pain, followed by numbness and tingling of the extremity, if the extremity is entirely deprived of blood, it dies and gangrene develops, generally with slow pain.

Large, dilated veins (varicose veins) are caused by defective valves in the veins. The distended veins produce chronic venous stasis with swelling of the extremity associated with pain and aching The onset of noninflammatory venous thrombosis (phlebothrombosis) is usually gradual, with severe symptoms of pain and throbbing through the entire extremity.

If a large artery or pelvic vein becomes occluded, nausea, vomiting, and abdominal pain develop.

Infection of the lymph vessels (lymphangitis) is characterized by malaise, chills, fever, and tenderness over the inflamed vessels The areas which are no longer drained by the inflamed lymph vessels swell with edema

THE BLOOD AND BLOOD-FORMING ORGANS

Introduction.—The main symptoms of blood dyscrasias are jaundice, pallor, bleeding gums, inflamed mucous membranes, and swelling of the lymph nodes.

The Anemias.—The most common blood disorders are the anemias. Anemia is a decrease in the number of red blood

A functional type of dyspnea or "sighing breathing" is seen in neurotic disorders such as anxiety.

Sometimes heart disease and lung disease exist together. Breathlessness may be the outstanding symptom of either condition. In such cases it is important to decide how much dyspnea is due to each. For example, dyspnea caused by asthmatic bronchitis may come and go for years without preventing the patient from living a normal life, while dyspnea resulting from a failing heart has a more serious outlook.

Orthopnea.—As cardiac function decreases, dyspnea increases until it is impossible for the individual to lie flat and be comfortable. This is called orthopnea. An unconscious patient cannot be orthopneic, since it is strictly a subjective symptom.

Cough.—Frequently patients with cardiac failure complain of cough and expectoration. Cough is produced by congestion of the lungs. The sputum, as previously described, is frothy. Cough is also produced by pressure of an aneurysm on the trachea, bronchus, or recurrent laryngeal nerve. If the cough is severe enough to interfere with sleep, it may cause an attack of nocturnal dyspnea.

Weakness, Anorexia, Nausea, Vomiting.—These symptoms are very common in congestive failure. They may be the result of congestion of the abdominal organs, or reflex stimulation of the central nerve pathways, or interference with the metabolism of the brain due to the poor circulation of the blood.

Fatigue and headache are other symptoms experienced by patients with heart disease, especially those with congestive heart failure.

Peripheral Vascular Disease.—Most patients with disease of the peripheral vessels suffer from the effects of a poor flow of blood through the extremities (*ischemia*). The vascular disturbance may be organic (arteriosclerosis) or functional (spasm). Insufficient blood supply is called ischemia. Ischemia produces coldness of the extremities, aching or pain on muscular activity, especially walking (intermittent claudication), and pain at rest. Intermittent claudication may at first produce aching, but with continued exercise, pain develops. Rest will give relief. This symptom indicates struc-

toms may be fulminating; they are prostration, chills, and fever. Fatigue, weakness, chilly sensations, and dyspnea are often prodromal symptoms.

Leukemia.—In general, leukemia may be considered neoplasm arising from the various blood-forming cell organs (spleen, liver, lymph nodes, and bone marrow) just as other tumors do from such tissue as the ovaries, brain, etc. Leukemia is manifested by an increase in the number of white blood cells in the peripheral blood. An exception to this is aleukemic leukemia in which there is a decrease in the number of white blood cells in the peripheral blood. The leukemias are divided into three types, depending upon the cell origin: (1) myeloid (myelogenous) leukemia, (2) lymphoid (lymphatic) leukemia, and (3) monocytic leukemia. The most common type of leukemia is chronic lymphogenous leukemia. The most frequent symptom is swelling of the lymph nodes in the neck The swelling of the lymph nodes is due to replacement of the normal lymphoid tissue by proliferation and increase in number of the lymphocytes in the glands. Other important symptoms are loss of weight and appetite, fever, sore throat, diarrhea, dyspnea, weakness, and fatigue. Acute leukemia is a fulminating disease and is usually accompanied by pallor, weakness, fever, and chills.

Another disease that affects the lymph nodes causing lymphocytosis is infectious mononucleosis. It is characterized by swelling of the lymph nodes in the neck, sore throat, fever, and headache Infectious mononucleosis is benign in nature, but it is frequently confused with leukemia.

THE GASTROINTESTINAL SYSTEM

Introduction.—The chief complaints of patients with disorders of the digestive tract are flatulence, discomfort and pain in the abdomen (dyspepsia), vomiting, sometimes of blood, and disturbed bowel action.

The organs of the digestive tract have a high incidence of disease, both organic and functional Besides, gastrointestinal symptoms may be the first or the most outstanding manifestation of diseases unrelated to the digestive tract For instance, brain tumor, scarlet fever, psychoneurosis, and pulmonary tuberculosis may cause various gastrointestinal symptoms.

cells in the blood. The three most common types of anemia are hemolytic anemia, hypochromic or iron deficiency anemia, and pernicious anemia. Other diseases associated with anemia are agranulocytosis, infectious mononucleosis, and the different forms of leukemia. Leukemia is a disease of the blood marked by a persistent increase in the number of white blood cells in the blood associated with changes in the spleen, liver, lymph nodes, and bone marrow.

The symptoms of hemolytic anemia are fever, palpitation, weakness, dyspnea on exertion, abdominal pain, and nausea. Acquired and congenital hemolytic jaundice are the most common of the hemolytic anemias. Toxic substances such as benzol and arsenic may inhibit the production of red blood cells (aplastic anemia) in the bone marrow. Aplastic anemia is characterized by skin rash and weakness Pernicious anemia shows itself by symptoms of weakness, palpitation, dyspnea, numbness and tingling of the extremities, sore tongue, and diarrhea.

Following chronic blood loss as seen in bleeding hemorrhoids or hookworm disease, the iron content of the blood decreases and the red blood cells become smaller in size than normal (hypochromic microcytic anemia). The onset is gradual with weakness, pallor, fatigue, and palpitation. Associated with chronic infections (malignancy, vitamin deficiencies, renal disease) and pregnancy is simple chronic anemia The symptoms are loss of strength, drowsiness, and pallor.

Anemia following acute hemorrhage results in sensations of coldness, sweating, faintness, and dizziness If blood is lost by internal bleeding, jaundice and fever may appear Symptoms of chronic hemorrhage depend upon the degree of anemia and the cause of blood loss (peptic ulcer, cancer of the bowel) The symptoms to appear first are weakness, easy fatigue, dizziness, dyspnea on exertion, and headaches.

Disturbances of Coagulation.—Disturbances of coagulation of the blood are characterized by frequent nosebleeds and skin rash. In these cases the blood platelets are diminished in number. Symptoms of abdominal pain, fever, erythema of the skin, itching, joint pain, and stiffness are common.

Such drugs as amidopyrine and the sulfonamides may cause a reduction in the number of white blood cells in the blood, particularly the granulocytes (granulocytopenia). The symp-

Pain arising from the gastrointestinal tract may be localized to the midline, if due to peptic ulcer, or referred into one of the four quadrants, as in appendicitis. Frequently the pain is related to meals or relieved by food. Sometimes special kinds of food produce pain (food allergy).

Very few visceral diseases other than cancer cause constant pain of long duration.

Nausea and Vomiting.—Nausea is a symptom of a vast variety of conditions. It is produced by reverse waves of peristalsis of the stomach and esophagus. It usually precedes vomiting. Nausea is difficult for the patient to describe but it is usually referred to the throat and stomach. The patient feels that he must vomit. He feels weak, dizzy, has headache and a feeling of emptiness. Nausea may be the first symptom of kidney disease, pulmonary tuberculosis, or heart failure. If associated with headache, it suggests migraine. If associated with vertigo, it suggests labyrinthitis. It is also associated with rapid changes of the patient's position in relation to the force of gravity, as in violent movements of sea ships and airships Nausea occurring early in the morning is a symptom of gastritis and particularly of chronic kidney disease. Severe nausea in the absence of vomiting is associated with cancer of the stomach, intestinal obstruction, liver disease, and gastritis.

Vomiting is the forceful expulsion of the stomach contents through the mouth. Organic disease of the stomach and upper portion of the small intestine are the most important causes of vomiting, but many other disorders of the digestive tract also cause vomiting. Early morning vomiting may accompany pregnancy. Vomiting occurring soon after eating is usually, but not always, functional in origin. Vomiting occurring one to four hours after eating is characteristic of gastric or duodenal disease. Vomiting preceded by severe headache occurs in migraine.

Patients with organic lesions of the stomach induce vomiting voluntarily to bring about relief from pain or indigestion. Emotional strain or anxiety may result in involuntary vomiting In some people, the sight of certain foods or unhappy or repulsive surroundings will cause vomiting

Constipation and Diarrhea.—Constipation is infrequent bowel movements. It may result from a delay in the forward move-

Organic diseases may be on the basis of infection, parasites, or tumors. Functional disturbances may be reflex or emotional in origin.

Dyspepsia.—Dyspepsia is indigestion. It is a vague complaint which includes a large *group of symptoms:* these are nausea, vomiting, belching (sour or bitter), loss of appetite, feeling of fullness in the abdomen, bad breath, and bad taste in the mouth. The patient experiences a vague, disagreeable *feeling in the stomach. Burning in the stomach, over the heart, and beneath the sternum,* accompanied by sour *belching, is* frequently called "heartburn." Belching (eructation) or bicarbonate of soda gives almost immediate relief. Nervous persons, who are chronic air swallowers, commonly complain of frequent tasteless belching. The eructation may be intentional.

Patients' descriptions of dyspepsia vary. It depends upon the individual's sensitivity to his digestive functions (his "threshold") and his *ability to express himself.*

Dyspepsia may arise from functional disorders of the stomach, or organic changes, such as ulcer or cancer; then again, it may be reflex from disorders of other abdominal organs, such as the gall bladder or the pancreas.

Pain.—Pain of the digestive tract is of three types: (1) visceral, (2) parietal, and (3) functional. There is some question whether pain can be felt in the abdominal organs themselves. Parietal pain is felt in the abdominal wall. A patient's threshold is important in digestive disturbances. Active *peptic ulcer* produces symptoms of gnawing, burning, and nausea If these increase in intensity, the patient feels pain, and this often indicates deeper penetration of the ulcer into the stomach wall. Patients in a high state of anxiety or emotional disturbance frequently feel abdominal pain and cramps which have no organic cause.

Pain produced by obstruction or acute spasm of the bowel may be severe It is usually intermittent with periods of remission of varying duration.

As a general rule, organic diseases cause severe pain, while functional disorders produce milder sensations. However, in a sensitive person, spasm of the colon or other functional disorders may be quite severe. Old people may be less sensitive to pain.

Bad Breath (Halitosis).—Neurotic patients frequently complain of bad breath, without this being apparent to others. Obstructive lesions of the colon, stomach, intestines, and esophagus are associated with bad breath or halitosis. Other causes are carious teeth and pulmonary infections.

Belching.—Belching is most frequently seen in psychoneurotics who are air swallowers. It is done to remove air and gas from the stomach. Hiccough may be transitory. If it lasts long, it is often a complication of a serious illness, such as uremia. It results from spasm of the diaphragm because of abnormal stimulation by the phrenic or vagus nerves.

THE GENITOURINARY SYSTEM

Introduction.—The most important symptoms of urinary tract disease are pain and blood in the urine; others are various *disturbances of micturition.*

Pain.—Kidney pain varies in character from a dull backache to pain of a colicky nature Pain of cystic disease of the kidney is felt in the back; it is dragging or bearing down in character. It may be increased on exercise or relieved by rest. Kidney stones (nephrolithiasis) when passing into the ureter produce a sudden agonizing colicky pain. This may occur in an individual who is apparently in good health. The pain is felt in the back over the kidney region, radiating into the abdomen or genitalia. The pain is so severe the patient feels faint, becomes nauseated and vomits, and has an increased desire to urinate. Between attacks a constant ache may remain in the loin.

Pain in the kidney region associated with fever and chills suggests kidney infection, either pyelitis or nephritis. Pain on urination and frequent urination commonly accompany these symptoms.

Burning, smarting, or pain during urination may also be due to lesions of the urethra (gonorrhea) and the bladder.

Hematuria (Bloody Urine).—Hematuria attracts attention first because it causes discoloration of the urine, or even the formation of blood clots. It is frequently associated with tumors of the kidney. The bleeding is mild or abundant, pain-

ment of the intestinal contents caused by an obstruction somewhere between the esophagus and anus. It may be secondary to poor eating habits, irregular defecation habits, lack of exercise, obesity, and nervous and mental disorders. For most people, one stool a day is normal. This may vary with the individual; some have habitually several stools a day and some one in several days. This latter condition is not constipation, and such persons do better if they do not interfere with their bowel habits. Constipation may occur at any age. When it is caused by impacted feces in the rectum, it produces symptoms of fullness or pressure in the rectum, frequent desire to move the bowels, and soreness of the anus. Patients suffering from chronic constipation complain of nausea, belching, bad breath, and bad taste in the mouth. Individuals who have chronic constipation are daily users of laxatives, which aggravate the condition. Long-standing constipation may be associated with toxic manifestations (malaise, headache, vertigo, fatigue, and muscle pains).

Diarrhea is abnormal looseness and frequency of the stools. It may be caused by some pathologic condition of the intestines (amebic dysentery) or some psychic disorder. Many public speakers and actors have diarrhea prior to their appearance on the stage Cramplike abdominal pain, burning of the anus, and weakness frequently accompany diarrhea.

Anorexia.—Anorexia is loss of appetite or a decrease of the normal feeling of hunger This occurs with pulmonary tuberculosis, advanced kidney diseases, neoplastic diseases, alcoholism, emotional upsets, and many other conditions.

Dysphagia.—Dysphagia is pain on swallowing This may be the initial symptom of cancer of the upper end of the stomach, diseases of the esophagus, and psychic disturbances.

Headache.—Headache is one of the most frequent symptoms associated with digestive disorders. Headache in the early morning may be a symptom of chronic gastritis.

Flatulence.—Flatulence is the feeling of gas in the gastrointestinal canal. In constipation it is associated with fermentation in the bowel Flatus may be increased in diseases which cause poor absorption of food, such as intestinal tuberculosis, sprue, steatorrhea, and regional enteritis.

Incontinence.—Incontinence is involuntary voiding of urine. This occurs commonly in children, especially at night (enuresis), and in patients who are unconscious or suffering from diseases of the central nervous system. Fright may cause involuntary voiding in a normal person. Uncontrolled flow of urine following laughter or cough is common during pregnancy and in women previously injured by childbirth. In men, dribbling following urination indicates chronic prostatitis, nerve disorders, or loss of muscle tone of the bladder. The same symptom is present in women who have a relaxed pelvic floor.

Oliguria.—Oliguria is scantiness of urine. This occurs from reduction of intake of fluid, dehydration, severe diarrhea, vomiting, and destruction of kidney tissue (nephritis). Mechanical hindrance to the flow of urine also produces oliguria. Severe pain originating outside the urinary tract may result in scanty urination. Following acute hemorrhage oliguria or complete anuria may develop.

Retention.—Retention is inability to urinate when the bladder contains urine. With retention of urine in the bladder, the patient feels the urge to urinate but is unable to do so. At the onset of acute retention, the patient feels a mild ache in the lower abdomen (suprapubic region) and the desire to urinate. As the retention continues and the bladder distends, the pain becomes excruciating. Chronic retention is incomplete emptying of the bladder. It develops gradually. The first indication is decrease in size or force of the stream. Pain is uncommon in chronic retention, since the bladder has a chance to stretch and accommodate itself to its defect.

THE MUSCULOSKELETAL AND ENDOCRINE SYSTEMS AND THE SKIN

The Musculoskeletal System.—Stiffness, pain, restricted motion, and local muscular weakness are the main symptoms of diseases of the joints—rheumatoid arthritis, hypertrophic arthritis, infectious arthritis (gonorrhea, tuberculosis), and gout.

Stiffness of chronic arthritis is worse in the morning on awakening or after prolonged inactivity. Exercise or "limbering up" gives relief

less and is not affected by rest or exercise. Inflammation of the bladder (cystitis) when acute may produce a bloody urine.

Anuria.—Anuria is lack of secretion of urine by the kidney. In anuria both kidneys are involved. The condition may result from congestion of the kidneys, as in nephritis, or from degeneration of the kidney tissue (lead and mercury poisoning), or bilateral ureteral obstruction by stones. The bladder in these conditions does not contain urine. Headache, lumbar pain, and vomiting are the most common symptoms, but often the patient feels remarkably well and only wonders why he passes no urine.

Anuria must be distinguished from retention (see below). In this condition, the kidneys function normally but the flow of urine is obstructed somewhere along its course.

Disease that impairs kidney function and obstructs the flow of urine, if prolonged, causes a retention of urinary waste products in the blood. This is called uremia. Usually symptoms develop slowly. They are headache, restlessness, weakness, nausea, vomiting, diarrhea, and constipation.

Frequency.—Normally an individual urinates five to eight times a day. Frequency of urination is a common symptom of genitourinary disorders. In some persons frequency is a habit; in others, frequency of urination indicates inflammatory lesions of the renal pelvis (pyelitis) or bladder (cystitis), bladder distention, and increased volume of urine (polyuria). Frequency at night occurs in nervous individuals who cannot sleep. Frequent urination of small amounts may indicate local disease of the bladder, urethra, pressure on the bladder, and retention of urine with overflow.

Polyuria.—Polyuria is passage of excessive amounts of urine. This symptom is part of numerous medical disturbances, such as pituitary diseases (diabetes insipidus), diabetes mellitus, or glomerulonephritis (Bright's disease). Excessive intake of fluid is a common physiological cause of polyuria. Frequency at night (nocturnal polyuria) is associated with the same group of diseases and particularly tuberculosis of the bladder.

Temporary polyuria usually occurs in nervous persons under emotional strain.

fatigue, palpitation, and inward desire pushing the individual to perform purposeless actions.

Hyposecretion of the thyroid gland results in listlessness and increase in weight. If it is severe and prolonged, mental retardation develops with marked listlessness and gain in weight, muscle fatigue, and backache. This is called myxedema.

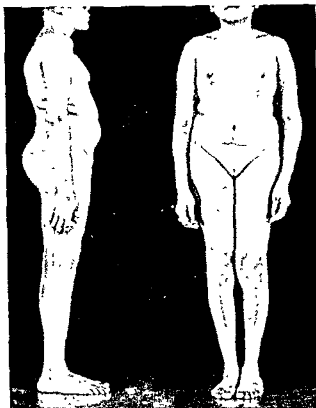


Fig 21.—Hypopituitarism Abnormal deposition of fat on the body (trunk and pelvic girdle), tapering of fingers (Courtesy Metabolism Division, Department of Internal Medicine, Washington University School of Medicine, St Louis)

The adrenal gland consists of a cortex and medulla and each has a separate function. Adrenal cortical insufficiency (Addison's disease) may occur as an acute or chronic disease. The symptoms are loss of appetite, vomiting, hiccough, abdominal pain, and rapid loss of weight. Hyperfunctioning cortical lesions, such as benign or malignant adenoma or

Pain may vary from a mild discomfort (aching) to severe and agonizing. This may be present even if the joint is at rest. Pain at rest associated with swelling characterizes almost all the arthritides.

Restriction of motion may vary from mild limitation to complete immobility. Pain on movement is common.

Local muscular weakness is usually a result of wasting of the muscles, in part due to lack of use because of the pain caused by the inflammatory changes about the joints.

Almost everybody is affected with some muscular disturbance at one time or other. Inflammation of muscles (myositis) manifests itself by symptoms of fever, weakness, malaise, muscular aching, and pain.

Muscular diseases associated with progressive loss of power are termed myopathies. In this group fall such diseases as myositis ossificans and fibrositis. The symptoms are muscular aching, wasting, limitation of movements of certain muscles, fever, and pain.

The Endocrine System.—The pituitary gland is known as the "master gland" of the body. Its secretions control or affect most of the other glands. Disorders occur in all races and sexes. In the adolescent female, decrease in function of the anterior lobe (hypopituitarism) produces amenorrhea. Deficiencies of the gland in young individuals cause excess gain in weight (juvenile adiposity) In adults, headache, fainting, constipation, nausea, and vomiting appear. The commonest manifestations of pituitary disease for which medical advice is sought are headache, abnormal smells and tastes, and epilepsy.

Hyperactivity of the anterior lobe produces abnormal height (gigantism) and enlargement of the bones (acromegaly).

The thyroid gland acts as a storehouse for iodine and produces a substance, thyroxin, which influences growth and body metabolism With colloid goiter (enlargement of the gland) pressure symptoms arise from mere enlargement of the gland. These are a sense of fullness in the neck and dyspnea from pressure on the trachea. The most important thyroid disorder is exophthalmic goiter. It is caused by abnormal secretion of the gland. The symptoms are variable, the most common complaints being excessive appetite, increasing sense of

Inability of the tissues to utilize glucose because of insufficient production of insulin by the pancreas is called diabetes mellitus. In diabetes, the sugar (glucose) in the blood increases (hyperglycemia), and since glucose is a diuretic, it increases the secretion of urine by the kidneys (polyuria). This loss of fluid causes dehydration of the body tissues, and



Fig. 23.—Hypothyroidism after thyroid therapy. Return to normal. (Courtesy Metabolism Division, Department of Internal Medicine, Washington University School of Medicine, St. Louis.)

because of this the patient experiences extreme thirst (polydipsia). The main symptoms are loss of appetite, itching of the genitalia, weakness, and loss of weight.

A low blood sugar (hypoglycemia) may result from Addison's disease and from an overdosage of insulin. The chief symptoms are weakness, hunger, tremors, fainting, nausea, and vomiting.

Disturbances of the male gonads may result in the failure of the male sex characteristics to appear.

carcinoma, are characterized by changes in the secondary sexual characteristics. In boys there is precocious puberty; in girls puberty is premature but the features become more masculine than feminine. The main symptoms of medullary hyperadrenalism are nausea, vomiting, tremor, and palpitation.

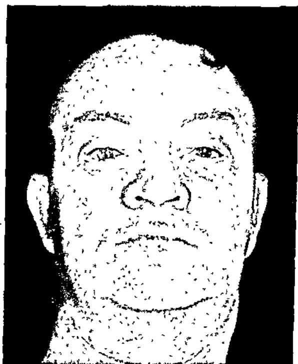


Fig 22.—Hypothyroidism before treatment. Dull expression, coarse features, puffiness of face. (Courtesy Metabolism Division, Department of Internal Medicine, Washington University School of Medicine, St. Louis.)

The parathyroid glands regulate the metabolism of calcium and phosphate. Hypoparathyroidism results in tonic spasm of the voluntary muscle (tetany) because of too little calcium in the system. In mild cases the patient complains of numbness and tingling and feeling of stiffness in the hands. When the condition is more severe, spasms of the hands, feet, and throat appear Hyperparathyroidism produces general symptoms of fatigue, weakness, polyuria, polydipsia (extreme thirst), backache, abdominal pain, vomiting, and loss of appetite.

CHAPTER 14

SIGNS OF DISEASE

Definition.—A sign is any change of structure or function in the body that is discovered by the physician on his examination of the patient.

Injury.—Injury is damage done to the body tissues. In general, there are two types of injury: simple and severe Simple injuries, such as bruises, damage tissue cells without impairing their viability. More severe injuries, such as third degree burns, actually kill the tissue cells. Death of tissue is called necrosis. When the amount of dying tissue is extensive and putrefaction or mummification occurs, it is called gangrene.

The various types of injurious agents may be classified as·

Chemical Agents: Serious tissue damage results from contact with such chemicals as acids, alkalies, and liquid bromide. Usually this is accidental. It occurs most often in large industries. Occasionally an individual will attempt suicide by drinking these dangerous substances. Medicines such as salves and solutions containing phenol are dangerous Phenol will produce cell injury and in some cases death of the tissue. Insect and snake bites contain toxic chemicals that injure the cells directly.

Mechanical Agents: These are the most common. Injury (trauma) occurs in everyday life The lesions produced are called wounds. A wound is an injury to any tissue of the body caused by mechanical violence A bruise is injury to the soft tissues without a break in the skin

Radiant Energy: Heat, x-ray, or radium can cause an inflammatory reaction. If severe, it will kill the tissue. Freezing

Sexual aging in women is due to the slowing down or cessation of ovarian function. The menstrual periods become progressively less frequent and more scanty until they cease (menopause). The main symptoms are "hot and cold flushes" and nervousness.

The Skin.—Subjective symptoms consist of itching, burning, stinging, tingling, prickling, sensation of heat, cold, or pain. Symptoms of headache, malaise, chills, and fever may be present in acute skin conditions but lack distinct characteristics in skin diseases.

Itching is the most common symptom in skin affections. It varies in degree and type. It may be a mild burning or prickling or so severe and intense as to be intolerable. The cause is probably irritation of the peripheral nerve endings from toxic substances, pressure, or external irritants such as parasitic infestations. Itching may be intermittent or continuous. It is frequently associated with scabies, mycotic infections (athlete's foot), and pediculosis. Itching is associated with metabolic disorders, nervous disorders, and liver disease.

Pain arising from the skin is not too common, except following injuries. It may be throbbing or pounding, as in boils, and stinging or boring, as in herpes zoster.

Frequently the only symptom is a rash This may be a single lesion on the skin or may be generalized, covering the entire body. The study of the various rashes and other disorders of the skin is a vast and important field which has developed into a specialty called dermatology. Because of its special and peculiar nature, it is not here considered in detail

Healing and Repair.—The process of healing or repair begins immediately with the dilatation of the blood vessels, diapedesis, exudation, and phagocytosis. Healing is influenced by (1) kind of tissue injured (bone has great powers of regeneration, while nerves have very little), (2) presence of bacteria (they may prevent healing), (3) constitutional factors (children have a greater power for healing than adults), and (4) the surgical technique which may have been used. Wound repair occurs by two methods: (1) healing by first intention, as in the case of the healing of uncomplicated surgical incisions, and (2) healing by secondary intention, in which case the healing is delayed by infection.

The signs of disease may become known to the patient and are then symptoms. Frequently signs of disease are the presenting complaints Symptoms make the individual more conscious of his health and often make him observe the signs of his disease. The nurse, by close attention to the patient's complaints and to the signs of disease, can be a great aid to the doctor in making the correct diagnosis.

THE NERVOUS SYSTEM

Motor System.—A patient's way of walking (his gait) may be the first clue to the diagnosis of disease of the nervous system. A spastic gait is a sign of disease of the corticospinal tract. The individual walks stiffly and has difficulty in performing smooth coordinated steps This type of gait is found in multiple sclerosis, spinal cord tumor, degeneration of the spinal cord, myelitis, diplegia, and cerebral hemiplegia. In paralysis agitans the patient bends the body forward, walks stiffly with the knees slightly flexed and the arms held rigidly at the sides, and rapidly shuffles forward or backward as in a trot. The arms are held at the side of the body and do not swing In tabes dorsalis the patient walks well if he watches the ground or his feet Since his position is maintained by sight, he walks poorly at night A staggering, unsteady gait may be due to alcoholism, drug poisoning, or general weakness In disease of the cerebellum or brain stem the patient has difficulty walking with the eyes open or shut. The gait of hysteria follows a bizarre pattern—the patient may drag

will kill the tissue. Cold or chilling will injure tissue. Electricity (amperage) will burn tissue; if the amperage is high, it will kill the tissue.

Pathogenic Bacteria: These are the most important and frequent causes of inflammation. Bacteria may produce damage and necrosis and threaten the life of the patient.

Reaction of the Body to Injury.—Injury to the tissues produces inflammation. *Inflammation is the local reaction of the body to injury or irritation.* Inflammation may be acute, subacute, or chronic. The symptoms and signs of acute inflammation are pain, swelling, redness, and increased heat. An example is furunculosis. Chronic inflammation is an inflammatory process of long standing in which the connective tissue proliferates. Examples are tuberculosis and syphilis. Subacute inflammation is a type of reaction between acute and chronic. An example is osteomyelitis. Acute inflammation produces a vascular and cellular response in the tissues.

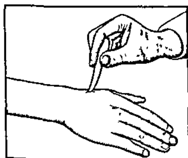
Vascular Response: Following injury there is first a transitory constriction of blood vessels, especially the small arteries or arterioles, but also the veins, capillaries and lymphatics. This is followed by a vasodilatation producing an increase in blood flow and lymph drainage. The vasodilatation is thought to result from the production of histamine which acts on the vessel wall, and reaction of the nerve mechanism of the blood vessels. The red color in the inflamed zone is due to the *increased blood flow.* This also explains the swelling and increased heat. Pain probably results from pressure on the nerve endings.

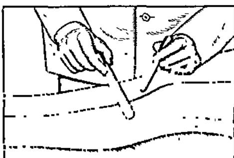
Cellular Response: This begins with the slowing of the blood flow. Blood cells (red blood cells and neutrophiles) begin to pass through the vessel walls into the zone of inflammation. This is called diapedesis. Other cells (macrophages) present in the tissue help the neutrophiles engulf the bacteria and debris (phagocytosis)

Exudative Phase or Humoral Response: This begins with the escape of serum through the capillaries along with the blood cells. This outpour of serum is called exudation. The serum dilutes toxins, furnishes antibodies, furnishes food to the cells, and neutralizes bacterial products

ances. A convulsive seizure beginning in one part of the body and gradually spreading to another is known as Jacksonian epilepsy.

Sensory Signs.—Analgesia is loss of sensation to pain. Hypoalgesia is diminished sensation to pain. Hyperalgesia is increased sensation to pain. Peripheral neuritis, syringomyelia, cord tumors, and cord injuries cause analgesia and hypoalgesia. Hyperalgesia occurs with disease of the posterior nerve roots. It is discovered by pricking the patient with a





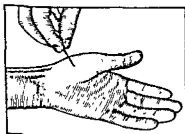




Fig. 24—Examination of the nervous system for sensation. (From Clendening and Hashinger: Methods of Diagnosis.)

one or both feet, demand support, or refuse to walk. The malingerer differs in that he can be tricked into a normal walk.

The posture in which the extremities are held may indicate a neurological disease such as paralysis agitans.

Paralysis is loss of the power of voluntary movements of the muscles. Flaccid paralysis follows disease or injury to the peripheral nerves, as in peripheral neuritis, or the anterior horn cells of the spinal cord, as in anterior poliomyelitis. Spastic paralysis occurs with disorders of the cortical spinal tract as in multiple sclerosis, brain tumor, and spinal cord tumors.

Speech disturbances should be noted during history taking. Slow speech occurs with Parkinsonism, hypothyroidism, and drug poisoning. Jerky, monotonous speech is heard with cerebellar disease and multiple sclerosis. Slurring of speech occurs in general paresis.

A tremor is involuntary shaking or trembling. The most frequent causes are old age, thyrotoxicosis, alcoholism, hysteria, drug addiction, neuroticism, and general paresis. A tremor which increases when the patient attempts to make a purposeful movement, such as combing his hair, is called an intention tremor. It indicates a cerebellar lesion or multiple sclerosis.

Involuntary repeated contractions of a certain group of muscles is called a tic Examples are blinking of one eye, twitching of a finger, or jerking of the head to one side.

Inability to perform skilled acts such as threading a needle may be seen in Parkinson's disease or cerebellar lesions.

Loss of power of rapid alternating movement such as pronating and supinating the forearm is called adiadokokinesis. This is another sign of cerebellar disease.

A convulsion is violent involuntary muscular contraction resulting in tonic or clonic contractions. Among the laity a convulsive seizure is called a "fit." In children a convulsion may be the first sign of an acute infection such as pneumonia. Epilepsy is a condition characterized by attacks of unconsciousness and tonic convulsions occurring at irregular intervals. They are frequently ushered in by premonitory symptoms called aura. These may be visual or aural disturb-

cortex and corticospinal tract. When diminished or absent, it indicates anterior horn cell (poliomyelitis) or posterior column (pernicious anemia) disease.

The tendon reflexes commonly examined are the biceps and triceps tendons, patellar and Achilles tendons, and abdominal reflexes. Stroking the lateral surface of the sole of the foot may cause dorsiflexion of the big toe. It is called Babinski's sign. It is normal in children but in adults it signifies disease of the corticospinal tract. To test for meningeal irritation the patient lies in the recumbent position and the doctor holds the patient's leg up in the air so that the thigh is perpendicular to the body and the calf is slightly flexed. By applying gentle backward pressure at the heel, the examiner tries to straighten or extend the leg at the knee. If the patient complains of pain or if the leg cannot be extended, the sign is positive. This is called Kernig's sign. Inability of the patient to stand with the eyes closed, the feet close together, and the arms held close to the sides of the body without swaying or falling is called Romberg's sign. It is positive in syphilis of the central nervous system, pernicious anemia, and vitamin deficiency. Disturbances of the nerves which supply the urinary and gastrointestinal tracts may result in incontinence of urine and feces. This occurs with spinal cord tumors and cerebral vascular accidents.

To test for anal reflex the doctor inserts his finger into the rectum. The sphincter muscles that hold the rectum closed are then felt to tighten and clamp down on the examining finger. This reflex is absent in tabes dorsalis and in neoplasms and lesions of the cauda equina

Disturbances of Speech.—Aphasia is failure to read, write, speak, and to understand written, printed or spoken words. This sign is found in multiple sclerosis, blindness, deafness, delirium, and depressive states.

Agnosis is failure to recognize color or shape of familiar objects. It is found in occipital lobe tumors.

Stupor and Coma.—Stupor is a state of unconsciousness with reduced response to outside stimuli. Coma is a state of profound unconsciousness from which the patient cannot be

pin. Deep nerve pain is demonstrated by pressure on a nerve. Loss of touch or tactile sensation and heat sensation occurs in the presence of spinal cord tumors. Loss of vibratory sense is demonstrated by the patient's inability to perceive the vibrations of a tuning fork held against the bones of the legs. It is a sign of disease of the posterior columns of the spinal cord and is found in pernicious anemia. Loss of position sense as shown in the heel-to-knee test also indicates disturbance of the posterior columns.



Fig. 25.—Positive Babinski sign. (From Clendening and Hashinger: Methods of Diagnosis.)

Reflexes.—A tendon reflex is involuntary muscular movement caused by a nerve impulse coming from a nerve center in response to a stimulus sent from the periphery to that nerve center. To test reflexes the patient must be relaxed. Increase or inequality of reflexes usually means disease of the brain

onset is sudden, with loss of reflexes, drooping of one eyelid, and dilated pupils that do not react to light.

A certain group of signs arise from involvement of the basal ganglia of the brain. They are seen most often in paralysis agitans, Huntington's chorea, and Sydenham's chorea. Paralysis agitans is characterized by a monotone speech, tremor, excessive salivation, slowing of movements, and bending forward of the trunk with a peculiar trotlike gait. Huntington's chorea is a hereditary disease manifested by facial grimacing, jerky gait, mental disturbances, and choreic movement of the face and hands. Sydenham's chorea has similar signs but a different clinical course, recovery being the rule.

Cerebellum: Signs of diseases of the cerebellum are rhythmical movements of the eyes in the horizontal, rotary, or vertical plane (nystagmus), tremor of the head and extremities with lack of coordination, and loss of power for rapid alternating movements such as turning the hands back and forth (adiadokokinesis).

Spinal Cord: Signs of spinal cord disease depend upon the location of the lesion in the spinal cord and the nerve tracts involved. Muscular weakness associated with wasting and loss of tone (atrophy), muscles that are relaxed and flabby with loss of voluntary movement (flaccid paralysis), diminished or absent tendon reflexes, and a positive Kernig's sign are signs that appear with destruction of the anterior horn cells of the spinal cord. A tendon reflex is involuntary contraction of a muscle when its tendon of insertion is tapped with a blunt rubber hammer. For example, tapping the tendon just below the "kneecap" causes involuntary upward motion of the leg. Kernig's sign is found in acute anterior poliomyelitis, progressive muscular atrophy, amyotrophic lateral sclerosis, and pressure on the spinal cord due to tumor. Loss of vibratory sensation, position sense, and positive Babinski and Romberg's signs are found in diseases producing degeneration of the peripheral nerves Vibratory sensation is demonstrated by placing a tuning fork against the bones of the body Position sense is demonstrated by having the patient close his eyes and place the heel of one foot on the knee of the opposite leg. The test is positive if the patient is unable to perform this simple task.

aroused. Head injuries, acute alcoholism, hysteria, cerebral hemorrhage, and drug poisoning are the most common causes of stupor and coma.

In brain tumors and brain abscess these signs are late manifestations. Cerebral hemorrhage ("stroke"), cerebral thrombosis, and embolism have an acute onset with unconsciousness and coma. Cerebral hemorrhage is followed first by a flaccid paralysis which later becomes spastic. Cerebral thrombosis occurs in elderly people with arteriosclerosis. In the younger age groups cerebral thrombosis is usually caused by syphilis. Cerebral embolism results from subacute bacterial endocarditis, auricular fibrillation, and myocardial infarction. In those conditions thrombi (clots) form on the inner surface of the heart. Pieces of these may break off and become lodged elsewhere in the body; they are called emboli In subarachnoid hemorrhage the onset is sudden and is followed by stupor. Coma is rare

Syncope, or fainting, is partial or complete loss of consciousness. It usually results from emotional disturbances, hunger, or from standing for a long time in a poorly ventilated room.

Signs Characteristic of Disease of the Nervous System.—Cerebral hemorrhage results in deep coma, hemiplegia, vomiting, and incontinence of urine and feces. A positive Babinski sign is present on the affected side. The spinal fluid is usually under pressure and is bloody. Cerebral arteriosclerosis of elderly persons results in numerous mental disturbances such as impairment of memory, irritability, and delusions Convulsive seizures in children may usher in meningitis, whooping cough, or encephalitis or indicate a congenital malformation of the brain. In adults it may indicate uremia or brain tumors.

Vomiting, stupor, slow pulse, slow respirations, choked optic discs, and convulsions are signs of brain tumor. If brain abscess is present there may be, in addition, chills and fever.

Acute bacterial infections of the meninges begin abruptly with convulsions, reflex changes, and a positive Kernig's sign, while tuberculous and syphilitic meningitis have a gradual onset.

Head injury may result in epidural or subdural hemorrhage, with stupor, slow pulse, coma, paralysis, choked discs, and slow snoring respirations. In subarachnoid hemorrhage the

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Absent tendon reflexes in the lower extremities, Argyll Robertson pupils, and difficulty in walking at night are signs associated with degeneration of the posterior roots of the spinal cord. As is seen in syphilis of the central nervous system, the Argyll Robertson pupil fails to contract when exposed to light; it will, however, contract on distant vision.

Tremor, nystagmus, lo [illegible] movement of one or more eye muscles causing a squint [illegible] tendon reflexes, and a positive [illegible] multiple sclerosis. *This disease produces signs that are usually generalized since there is a patchy degeneration of the myelin sheaths of the nerves.*

Syringomyelia *is characterized by degeneration of the cord tissue with cavity formation in the spinal cord usually involving the pain and temperature fibers of the spinothalamic tracts; as the cavities enlarge they involve the anterior horn cells, the corticospinal tracts, and the posterior columns. The main signs are loss of pain and t[illegible] exces-sive sweating of the skin, loss of [illegible] tion, increased tendon reflexes, positive [illegible] atrophy of the shoulder muscles.

Mental Disturbances.—

Psychosis: The manic-depressive patient appears *to be* in a severe state of worry and is uninterested in his *surroundings*. He is, however, well oriented as to time and place. He will pace the floor and *mutter to* himself. *Often he* passes from *depression* into *extreme* elation With this phase, the patient will appear overactive and overtalkative, passing from one subject to another

The schizophrenic will show extremes of laughter, bizarre positions of the limbs, and hear imagined voices.

The paranoid is suspicious of everyone, giving side glances of distrust.

Organic Psychosis: In *cerebral arteriosclerosis* the first mental changes noted are decrease in intellectual power, loss of *memory* for recent events, and confused thinking Individuals with brain tumors may have a flat facial expression. In general paresis the first manifestations are decrease in memory and delusions of *grandeur*. An *alcoholic* is overtalkative and careless *about* his appearance *and* dress.

Psychoneurosis: Individuals in a high state of anxiety appear flushed and tense and have a variable pulse rate with changes in blood pressure. Hysterical persons will always change the subject of conversation when the cause for their reactions is approached. Examination fails to reveal objective changes in a patient displaying hysterical blindness or paralysis. The hypochondriac always shifts the conversation to his concern about his health. Signs of overfatigue may resemble the anxiety state.

THE HEAD AND NECK

Head.—

Cranium: An abnormally small head (microcephalus) may result from congenital syphilis, fetal encephalitis, or injury to the brain cells from hemorrhage. Hydrocephalus (an abnormally large head) is globular in shape with wide fontanels. This is due to an excessive production of cerebrospinal fluid by the small capillary tufts (choroid plexus) in the lateral ventricles. This produces an increase in the spinal fluid pressure which results in a dilatation of the ventricles. In adult life enlargement of the skull indicates acromegaly or Paget's disease Congenital syphilis may cause an enlarged, prominent forehead with narrowing of the chin (square head).

Subcutaneous nodules which appear on the cranium may occur with multiple sclerosis or as metastases from malignant tumors. With skull fracture an actual depression in the bone is sometimes felt. The mass of blood in the subcutaneous tissue (hematoma) that follows is palpable

Loss of hair may follow acute infections or occur almost physiologically with age Premature baldness is usually a hereditary tendency With skin disease of the scalp (ringworm), myxedema, and secondary syphilis a patchy baldness may appear Premature graying occurs sometimes between the ages of 30 and 35 years. It may be associated with pernicious anemia

Tenderness with swelling over the orbit may result from frontal sinusitis. Tenderness below the eye indicates maxillary sinusitis

Face: Patients with thyrotoxicosis have protruding eyeballs and a startled or frightened expression. An individual show-

ing a puffy face and dry skin may be suffering from myxedema or nephritis. In nephritis the skin will pit but not in myxedema. The outstanding signs of acromegaly are generalized enlargement of the bones of the head.

Mouth breathing, a frequent finding in children, is usually due to hypertrophied adenoid tissue (tonsils and adenoids).

Edema of the face gives a puffy appearance and will pit on pressure. It occurs in nephritis, nephrosis, and erysipelas.

Muscular paralysis of one side of the face produces a wider palpebral fissure, drooping of the corner of the mouth It is found in Bell's palsy or hemiplegia from a cerebral vascular accident.

A red nose, although normal for some persons, may be due to chronic alcoholism or to a skin condition called rhinophyma.

The pinched, drawn expression with dry pale skin and sunken cheeks, is a sign of dehydration which results from prolonged vomiting and diarrhea.

With age, dry, raised, rough, brown areas appear on the skin These are called senile keratoses. Abnormal color of the skin is frequently a significant sign of some underlying disease Jaundice indicates obstruction of the flow of bile from the gall bladder, liver disease, malaria, or severe lobar pneumonia. With pernicious anemia the skin has a lemon-yellow tinge. Cyanosis or blue color is seen in heart failure and pulmonary disease Pellagra, diabetes, and arsenic poisoning may produce a brownish discoloration of the skin.

Spasm of the face muscles can occur with trigeminal neuralgia, uremia, drug addicition, chorea, birth injuries, encephalitis, and tetany It may also be a simple habit (tic)

Eyes: Frequently changes about the eyes are a manifestation of some systemic disturbance Edema of the eyelids is commonly associated with nephritis, acute sinusitis, anemia, diabetes, and angioneurotic edema Widening of the palpebral fissure associated with frequent blinking and a staring expression accompany thyrotoxicosis This is called Stellwag's sign. Von Graefe's sign is failure of the upper lid to follow downward movement of the eyeball. It is a sign of thyrotoxicosis.

Sunken eyeballs (enophthalmos) is seen in acute dehydration. Occasionally it is congenital. Markedly protruding

eyes (exophthalmos) is normal in some persons but is more often a sign of myopia or thyrotoxicosis. Very hard tense eyeballs are found in glaucoma. Very soft eyeballs are found in diabetic coma.

In conjunctivitis the eyelids are red and swollen. This is frequently associated with infectious diseases such as measles and whooping cough. Chronic granulated eyelids are a sign of *trachoma.*

With old age a grayish-white ring may appear around the cornea (arcus senilis). Clouding of the cornea occurs with corneal ulceration and interstitial keratitis. Interstitial keratitis is frequently a manifestation of congenital syphilis.

Swelling and discoloration and a sluggish reaction of the pupil to light are signs of infection of the iris (iritis).

The Argyll Robertson pupil has already been described. It is a sign of syphilis of the central nervous system. Constricted pupils are seen with old age and in morphine addicts. Unequal pupils may be normal but are often a sign of neurosyphilis A grayish opaque pupil indicates cataract.

The interior of the eye is examined with an ophthalmoscope. This must be done in a dark room. The patient is instructed to look straight ahead over the examiner's shoulder and not into the light of the instrument. Then the examiner adjusts the instrument so he can clearly see the retina. In normal eyes the retina appears red, and the blood vessels of the retina and the optic nerve are clearly visible. Normally the veins are twice the size of the arteries. In the normal eye no vessel wall can be seen. The optic nerve head appears as a whitish circular disc which may be flat or show a small amount of cupping. Along the nasal margin of the disc there is a small line of brown pigment. The retinal vessels have their largest diameter where they are seen to leave the optic disc. As they fan out to the periphery of the retina, they gradually become smaller.

Frequently the first sign of arteriosclerosis appears in the retinal arteries The arteries are spastic and appear narrow, and the vessel wall becomes visible with a white line appearing in the lumen of some of the vessels. In malignant hypertension and advanced arteriosclerosis the arteries show an irregular caliber, tortuosity, beading, and nicking of the veins where they are crossed by the arteries. Occasionally small

flame-shaped, cherry red areas (hemorrhages) or white areas (scarring of healed hemorrhages) are visible.

The presence of hemorrhage or scarring along the course of the retinal vessels suggests diabetes, nephritis, or hypertension. Very small retinal hemorrhage may be found in severe anemia. Hemorrhagic areas appearing to be fresh and containing small white centers are typical of advanced leukemia.

A swollen optic disc without evidence of inflammation is known as papilledema. This condition is found in patients with brain tumors, brain abscesses, and meningitis and in the late stages of nephritis, malignant hypertension, and leukemia. The swelling of the disc is usually due to an increase in the intracranial pressure which results from an increase in the pressure of the cerebrospinal fluid

Primary optic atrophy is usually due to syphilis of the central nervous system. The optic disc appears chalky white and smaller than normal, with sharply outlined edges. As the disease progresses the disc becomes grayish This condition is also found in multiple sclerosis.

Abnormal cupping of the disc is due to glaucoma. The cupping is due to the elevated intraocular pressure. Since the center of the optic disc is the weakest part, it is pushed backward, giving it the cupped appearance.

Ears: Deafness may be due to impacted cerumen (wax), a foreign body in the ear canal, or disease of the middle ear. This is called conduction deafness. Disease of the cochlea resulting from syphilis, otosclerosis, or drugs causes perception deafness.

Small, hard, firm subcutaneous nodules of urates (tophi) in the ear lobes are characteristic of gout. Bleeding from the ear following a blow to the head indicates a severe skull fracture. A purulent discharge is evidence of infection of the auditory canal or of the middle ear

Nasopharynx; Mouth; Nose: In acute pharyngitis and laryngitis the throat is inflamed and swollen The mucous membrane is shiny and red. Chronic inflammation of these two regions is common among heavy cigarette smokers and alcoholics. In tonsillitis, the tonsils are enlarged, red, and swollen and covered with small, raised, yellow-whi

Tonsillitis is frequently the first sign of infectious mononucleosis. Diphtheria produces a dull gray membrane that is firmly attached to the mucous membrane of the throat. Ulcerations of the throat may be signs of syphilis, agranulocytosis, or tuberculosis. Perforation of the palate may be due to congenital syphilis.

A dry, shriveled tongue results from mouth breathing or dyspnea and from dehydration. In anemias the tongue is smooth and pale. A white-coated tongue with large projecting red papilla (strawberry tongue) is seen in scarlet fever. An abnormally large tongue is associated with myxedema. Luekoplakia is a white, smooth area on the tongue or any mucous membrane. It is a sign of cancer. Canker sores or fever blisters are temporary and are frequently found in head colds and when the general health is lowered for other reasons. Ulcerations that fail to heal and fail to respond to local treatment may be due to cancer, tuberculosis, or syphilis.

Red, swollen, bleeding gums indicate gingivitis. Heavy metals like lead, bismuth, and mercury cause areas of brown-black pigment deposits on the gingiva. Chronic gingivitis results in a Vincent's infection (pyorrhea). Hypertrophy of the gums is occasionally seen in leukemia. Nontender, firm, fixed tumors on the gums may be caused by benign or malignant growths. The same type of ulcerations may be found on the lips that appear on the tongue. Harelip, a congenital deformity, is caused by failure of the two sides of the lip and, sometimes the palate, to fuse.

Neck.—Enlarged lymph nodes may be a sign of syphilis, infectious mononucleosis, Hodgkin's disease, leukemia, cancer, or tuberculosis. The parotid and maxillary glands swell in mumps. Abnormal enlargement of the thyroid gland occurs with thyrotoxicosis and colloid goiter.

A stiff neck may result from overexposure to cold, meningitis, cervical arthritis, strain, and infection of the neck muscles.

Distention of the jugular veins is usually associated with congestive heart failure. Vigorous pulsations of the carotid arteries may be a sign of thyrotoxicosis, aneurysm, hypertension, and aortic regurgitation.

The trachea normally lies slightly to the right of the midline of the suprasternal notch. Lateral displacement is felt in

thyroid enlargement, aneurysm of the aorta, and mediastinal tumors. A downward tug on the trachea is occasionally found with aortic aneurysm.

Signs of Diseases of the Cranial Nerves.—

Olfactory: Loss of sense of smell (anosmia) may be due to allergic rhinitis, head cold, or brain tumors on the undersurface of the frontal lobe. In case of head injury, anosmia indicates fracture of the anterior fossa of the skull involving the cribiform plate.

Optic: Blurring of the disc may be a sign of syphilis. Papilledema is seen in increased intracranial pressure.

Oculomotor; Trochlear; Abducens: Rhythmic back-and-forth novement of the eyeballs in a horizontal or vertical plane nystagmus) is frequently seen in diseases of these three erves. Drooping of an eyelid and a dilated pupil result from peripheral lesion of the third nerve. Inability to move the ye outward indicates sixth nerve palsy.

Trigeminal: Loss of blinking when the cornea is gently uched with a wisp of cotton (corneal reflex) is an early gn of fifth nerve disease. This reflex is not lost in trigeminal euralgia. It is always absent in coma. Part of the trigeminal erve controls the muscles (masseter and temporalis) which e used for chewing and opening the mouth. When this vision (motor nerve) is diseased, the muscles are weak, and hen the mouth is open, the jaw deviates toward the weak le.

Facial: The most common cause of peripheral nerve disrbance is Bell's palsy—flattening and drooping of one side the face

Auditory: This nerve consists of two distinct nerves, namely, e cochlear and the vestibular, the first having to do with aring and the second with equilibrium. Both are sensory rves. The lesions affecting the auditory nerve are meninis and tumors. Disturbance of the cochlear nerve causes pairment of hearing. Disturbance of the vestibular nerve nifests itself by dizziness or by a staggering, swaying gait.

Glossopharyngeal: The principal signs of involvement of s nerve are difficulty in swallowing (dysphagia) and loss sensation in the upper part of the pharynx.

Vagus: The dominant signs are cardiac disturbances such as slowing of the heart rate and alteration of rhythm. Tumors of the recurrent laryngeal nerve, a branch of the vagus, cause hoarseness and loss of voice (aphonia).

Accessory: Lesion of this nerve results in inability to turn the head completely to one side because the sternocleidomastoid and trapezius muscles are paralyzed.

Hypoglossal: Paralysis of the twelfth nerve causes deviation of the tongue to one side when it is protruding from the mouth. Normally the tongue protrudes in the midline

THE RESPIRATORY SYSTEM

Introduction.—The size and shape of the chest varies in health and disease. Large, barrel chests, that are wider than normal from front to back, are seen in elderly people, if skeletal changes have occurred, and in emphysema. Abnormally small, narrow chests are seen in individuals who have had rickets (vitamin D deficiency) in infancy or who have been confined to bed with a chronic illness

Prominent ribs, scapulae, and clavicles without change in shape of the thorax is usually a sign of loss of weight (emaciation). This often occurs in the course of chronic illness such as tuberculosis or cancer. Patients who have suffered from rickets may have a prominent sternum ("pigeon breast"). When the base of the sternum is depressed, the thorax resembles a funnel ("funnel chest") Small swellings felt at the junctions of the ribs with the sternum indicate rickets (rachitic rosary) They may, however, be congenital

The common belief that the flat, narrow chest in the anterior-posterior diameter is always associated with tuberculosis or chronic pulmonary disease is without foundation.

An increase in the anterior-posterior diameter of the chest may result from backward curvature of the thoracic vertebrae (kyphosis). When due to tuberculosis of the spine, a large "hump" may appear resulting from collapse of the diseased vertebrae. This is called the "hunchback." Lateral curvature (scoliosis) of the spine produces asymmetry of the chest.

Shrinkage of one side of the chest is usually associated with fluid in the pleural cavity (hydrothorax) or air in the pleural cavity (pneumothorax).

A localized prominence on the chest wall occurs with tumors and saclike lesions of the aorta (aneurysm).

Bleeding nipples or masses in the breast indicate benign or malignant tumors.

Percussion of the chest wall by gently tapping the surface with the finger determines the density of the underlying structures.

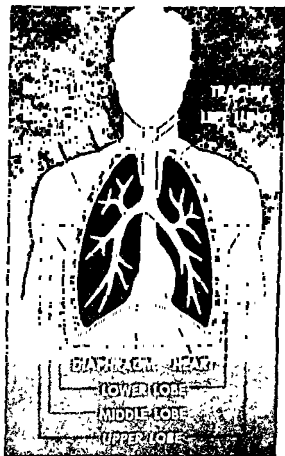


Fig. 26.—Schema of normal chest. (Courtesy of National Tuberculosis Association, Medichrome, Clay-Adams Co., Inc.)

The sense of touch (palpation) determines the texture of the skin, muscular spasm, inequalities in lung expansion, and the vibration felt when the patient speaks aloud (vocal fremitus).

Listening with the stethoscope to the breath sounds or spoken words (vocal resonance) that are referred through the chest wall is called auscultation. Râles are abnormal sounds of varied character heard on auscultation of the chest. Friction rub is a grating sound heard when the infected pleural surfaces come in contact.

Physical signs of tracheitis are usually absent. Fever, if present, is of low degree. The cough is dry and lasts three or four weeks. A foreign body (such as a peanut) or infection (tuberculosis) in the trachea may cause partial or complete obstruction of the lumen (tracheal stenosis). Dyspnea occurs on both inspiration and respiration. Cough is usually present

In bronchitis physical examination reveals very little unless the small bronchi become infected (bronchiectasis or pneumonia); then râles are heard.

In asthma the alveoli become blocked with secretions and as a result air enters the lungs but is held in the air sacs. During expiration the lungs cannot expel air from the alveoli, and a wheezing sound is heard, associated with labored short respirations and restricted motion of the chest.

With chronic inflammation, the alveoli lose their elasticity and expand, becoming larger than normal. This permanent distention of the respiratory passages is called bronchiectasis. On physical examination moist râles are heard at the lung bases.

The signs of pneumonia (lobar pneumonia, bronchopneumonia, and primary atypical pneumonia) are variable and may simulate each other. The most common findings are fever, diminished breathing on the affected side, dullness on percussion, increase or decrease in breath sounds, pleural friction rub, rapid breathing, and cyanosis

Edema.—Edema of the lungs occurs in heart failure and is determined by the presence of moist râles and alteration in the breath sounds at the bases of the lungs. These signs may suggest pneumonia, but the fever and symptoms may be absent. In debilitating diseases and old age the circulation of the blood through the lungs is slow, and edema of the lungs will occur. This is called hypostatic congestion of the lungs.

Hemorrhage.—When a blood vessel in the lungs ruptures, massive pulmonary hemorrhage is the result. Expectoration

of large quantities of blood (hemoptysis) occurs in tuberculosis, bronchiectasis, and pneumonia. If blood is swallowed, black, tarry stools and coffee-ground vomitus will appear within a few hours.



Fig 27.—Typical multiple tuberculous cavities (Courtesy Department of Radiology, St Luke's Hospital, St Louis.)

Tuberculosis.—Finding tubercle bacillus in the sputum is positive proof of tuberculosis The most prevalent clinical findings are cough, blood in the sputum (hemoptysis), loss of weight, hoarseness, and fever With minimal lesions occurring in the apices of the lungs, signs are frequently absent.

Tumors.—Primary malignant tumors of the lungs are uncommon. Secondary neoplasms are always malignant and are metastases from growths in other organs of the body. Hemoptysis is common. The physical findings are few and deceiving.

Tumors of the mediastinum produce enlargement of the lymph nodes in the neck (metastases), distended veins in the arms and neck with edema, and lateral displacement of the trachea with partial stenosis.

Atelectasis.—Atelectasis is an airless condition of the lungs. Signs of dyspnea appear only when a large amount of lung tissue collapses. The physical findings depend on whether the bronchus is open or closed.

Emphysema.—Emphysema is increased inflation and dilatation of the alveoli. Senile emphysema produces a barrel chest and is one of the normal changes seen in advancing age. When the function of the lung is hindered by disease, the remaining lung tissue becomes hyperactive and assumes the part of the diseased lung. This is called compensatory emphysema.

Fluid.—The presence of fluid between the two layers of pleura (pleural effusion) is a frequent complication of lung tumors and pneumonias of all types.

Pleuritis.—Acute inflammation of the pleura (pleuritis) produces very few signs The most common are friction rub and restriction of movement of the affected side by pain.

THE CARDIOVASCULAR SYSTEM

Introduction.—Signs of heart disease can be present without symptoms. Symptoms of heart disease arise only after the heart begins to fail These were discussed in Chapter 13.

Enlargement of the Heart.—*Enlargement of the heart* is a sign of heart disease There are two types of cardiac enlargement: (1) dilatation and (2) hypertrophy. Dilatation occurs when the heart is placed under unusual strain as in infections (pneumonia). The muscle fibers become weak and stretch Hypertrophy is a general increase in the bulk of the heart muscle fibers without an increase in their number. The heart normally dilates during exercise and exertion. This is tem-

porary, and the heart returns to its normal size. Pathological dilatation occurs with hypertension (high blood pressure) and disease of the heart valves. In heart disease dilatation occurs first, followed by hypertrophy. *With enlargement of the heart* its outward thrust against the chest wall is easily observed



Fig 29—Cardiac hypertrophy showing elongation of the aorta and enlargement of the right and left ventricles, and increased hilar shadows (Courtesy Department of Radiology, St Luke's Hospital, St. Louis.)

in the precordial area With each beat of the heart the chest wall vibrates and appears to rise and fall. As the heart continues to enlarge, the area of vibration increases in size. The intensity or force of the vibration depends upon the strain

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Besides the pulsations produced by the heart's action against the chest wall, expansile pulsations may be observed from saclike outpouchings from the aorta (aneurysm). Pulsations over the base of the heart or in the suprasternal notch may be due to aneurysms of the subclavian or innominate arteries.

When the heart is weakened by disease it lacks sufficient strength to push the blood from the venous side of circulation to the arterial side. This causes a backing up of blood into the veins, and as a result they become overloaded and distended. In normal persons the veins of the neck are collapsed when they sit in the upright position. Distention of the veins of the neck and upper extremities occurs with congestive heart failure. When the venous pressure is abnormally high, pulsations will be visible in the veins.

Thrills.—Thrills are vibrations transmitted through the chest wall by the heart and aorta. If the hand is placed over the precordial area, a sensation is felt similar to that felt when the hand is placed on a purring cat. A thrill is caused by eddies of current that exist beyond a narrow opening. Thrills are usually caused by defects in the valves (aortic or mitral stenosis) resulting from rheumatic fever. Thrills are also felt in individuals with hyperactive hearts due to hyperthyroidism Other conditions that produce palpable thrills are aneurysms and congenital defects such as a patent ductus arteriosus

Blood Pressure.—Blood pressure, as the pulse, has a wide variation in normal persons. In normal young adults the systolic blood pressure varies between 90 and 140 mm of mercury; the diastolic varies between 65 and 90 mm of mercury. Marked changes of blood pressure occur during physical exercise and emotional stress The blood pressure may increase to 160 mm. of mercury systolic and 90 mm. diastolic An increase in the blood pressure above the normal values is called hypertension. Transitory elevations will occur during exercise, but this is of little importance. An elevation of the systolic pressure without an elevation in the diastolic pressure may occur in hyperthyroidism. In general, most diseases causing high blood pressure produce elevations in both the systolic and diastolic pressure. The blood pressure may increase in diseases that impair the function of the kidneys (nephritis).

placed on the heart. In exercise, excitement, hyperthyroidism, and diseases such as hypertension and aortic regurgitation which produce enlargement of the heart, the vibrations on the chest wall are forceful and strong. However, the force of the vibration depends upon the thickness of the tissues in the chest wall. In acute cardiac dilatation or a failing heart the vibrations may be weak and feeble.

Rate.—The heart rate remains normal in most cardiac disturbances until tachycardia (rapid heartbeat) or heart failure develops. An abnormally slow pulse (bradycardia) is usually a sign of slow sinus rhythm, severe heart block, or toxemia due to uremia. It also occurs during convalescence from high fever.

The pulse rate is not always a true measurement of the heart rate. Cardiac arrhythmias such as auricular fibrillation cause an irregular rhythm varying in rate and force, and the feebler contractions are not transmitted to the pulse.

Normally the radial pulse has a regular rhythm without any alteration of force. The pulse of sinus arrhythmia is felt as [illegible] in rate during inspiration and a decrease [illegible] in the force. [illegible] rhythm and force With premature [illegible] s) of the heart, the steady, regular rhythm of the pulse is interrupted at varying intervals with a strong beat followed by a long pause before the next beat is felt A pulse that is felt to rise suddenly with extreme force and then to disappear suddenly is called a collapsing pulse It is best seen and felt when the arm is held up in the air This is found in thyrotoxicosis and acute febrile states A very pronounced collapsing pulse is called a Corrigan pulse and occurs in aortic regurgitation and patent ductus arteriosus The arteries of individuals with marked arteriosclerosis may be tortuous and show back-and-forth movement (buckling) with each beat of the heart

The carotid arteries in the neck are commonly seen in normal individuals Pulsations are normally seen in patients who are nervous or thin. Marked pulsations of the carotid arteries are seen in patients suffering from thyrotoxicosis, hypertension, and aortic regurgitation The same diseases may cause visible pulsations of the arteries in the upper and lower extremities.

In cardiac failure and myocardial infarction fever is usually low grade due to absorption of the broken down cells in the myocardium. A septic type of fever is often the first sign of subacute bacterial endocarditis. In pericarditis the presence of fever depends upon the etiology.

Signs of Peripheral Vascular Disease.—Pathological changes occurring in blood vessels cause a change in the circulation of the blood. In the early stages of arteriosclerosis the arteries are firm and not compressible. As the disease progresses, the vessels become tortuous and hard from calcification. The calcifications are felt as small, hard, beadlike elevations along the course of the artery. With impairment of circulation, the feet become cold to touch and appear thin. The pulsations of the arteries may be absent On elevation, the foot becomes pale; when dependent, the skin becomes cyanotic and red. With extreme impairment of circulation, ulcerations and gangrene may appear.

Extreme redness, cyanosis, and pallor of the finger tips, occurring in young people, particularly women, is characteristic of Raynaud's disease The toes are rarely involved

Buerger's disease (thromboangiitis obliterans) is confined to middle-aged men and most commonly involves the legs and feet The vessel walls do not feel thick or beaded as the vessels do in arteriosclerosis The pulsations of the arteries in the upper extremities are usually weak The tips of the fingers and toes are pale In severe cases they become cyanotic. Severe pain associated with ulcerations and gangrene is a late manifestation

Sudden pain occurs in the extremities when the blood supply is cut off; the leg becomes pale, white, and pulseless and remains so until recovery or gangrene develops. With the onset of gangrene, the skin becomes dry, shriveled, and mummified. As gangrene progresses, the skin turns black.

Abnormal distention of veins in the upper extremities is a sign of increased venous pressure as occurs in heart failure. Tortuous, dilated, superficial veins in the lower extremities (varicose veins) result from weakness of the veins and of their valves In varicose veins of long duration the skin around the affected veins becomes brown. This pigmentation is ascribed to stagnation of blood.

With congenital stricture of the aorta (coarctation), hypertension occurs in the upper extremities, while a hypotension (low blood pressure) exists in the lower extremities.

Hypotension is found in such chronic diseases as tuberculosis and Addison's disease. Low blood pressure also occurs in acute cardiac failure resulting from myocardial infarction and peripheral circulatory failure that follows acute hemorrhage.

Edema.—Edema is an abnormal accumulation of fluid in the tissues. The result is swelling. The most common causes are heart and kidney disease and local obstruction of the circulation. The edema "pits" on pressure. Since it is painless, patients often pay little attention to the swelling in its early stages. Edema is always an important indication of underlying systemic disease. Edema of the superficial tissues may be absent but still be present in the internal organs (liver and spleen). Generalized massive edema of the body with ascites is called anasarca.

Cyanosis.—Bluish color of the mucous membranes and skin (cyanosis) is usually a late manifestation of heart failure. In congenital heart disease it may exist through the entire life of the patient. The most common congenital disease causing cyanosis in adults occurs in a combination of defects: stricture of the pulmonary artery, interventricular septal defect, hypertrophy of the right ventricle, and location of the aorta to the right side of the heart. This is known as the tetralogy of Fallot. Congenital heart disease such as dextrocardia and stricture of the ascending aorta (coarctation of the aorta) may exist without cyanosis. Clubbed fingers and toes is a frequent finding associated with chronic cyanosis but occurs as a late manifestation.

Dyspnea.—Shortness of breath (dyspnea) and shortness of breath when the patient lies in a flat position (orthopnea) are more commonly symptoms rather than signs. These may appear in such diseases as myocardial infarction and congestive heart failure.

Skin.—The skin may present signs of associated heart disease; for example, the malar flush of mitral disease and the pink complexion of aortic stenosis These signs are not too reliable.

Inflammation of the veins (thrombophlebitis) occurs most frequently in the lower extremities. The skin over the vein is tender, red, and swollen, and the thrombosed vein may be felt as a cord under the skin. When deep veins become inflamed, edema and tenderness are the prominent signs. Pain in the calf on dorsiflexion of the foot (Homan's sign) may be an indication of deep thrombophlebitis.

THE BLOOD AND BLOOD-FORMING ORGANS

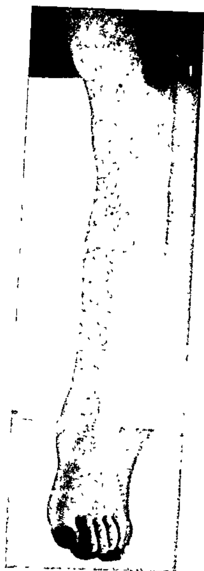
Anemia.—The most striking sign of decrease in the number of red blood cells in the blood (anemia) is pallor of the skin, mucous membranes, and nail beds. In acute hemorrhage due to severance of a large artery or bleeding peptic ulcer, the skin appears waxy and white The respirations become rapid and shallow, and the pulse rate increases. The pulse feels weak and thready. The loss of blood causes the blood pressure to fall, particularly the systolic pressure.

With chronic loss of blood, as occurs in cancer of the bowel, or bleeding hemorrhoids (piles), there is a decrease in the amount of iron in the blood (hypochromic anemia). The skin appears pale with very little change in the blood pressure. The fingernails become spoon shaped and brittle (koilonychia)

It is important to remember that fainting produces pallor without loss of blood This is due to the narrowing of the peripheral blood vessels (vasoconstriction). Some people normally have a pale skin Following blood loss, fever may occur, but it is not common unless the loss of blood is severe.

Anemia resulting from absence of an antianemic factor in the liver and failure of the stomach to secrete an unknown anemia-preventing substance necessary for red blood cell formation is called pernicious anemia The onset is insidious. The skin becomes pale and develops a lemon-yellow tinge When the anemia is severe, fever is common The margins of the tongue become sore, smooth, and red. The signs of complicating nervous system involvement occur, the deep tendon reflexes may be increased or decreased and tuning fork vibrations are not felt over the bones of the lower extremities

Sickle-cell anemia is a disorder confined to Negroes The red cells assume a crescent shape (sickling). Patients with this disease develop chronic leg ulcers, moderate enlargement



patient is a young man, aged 28
utated previously. Note the deep
hen hanging in a dependent posi-
and second toe. No pulsation in
artery The popliteal can be felt
Amputation was ultimately done.
(From Berman. Principles and Practice of Surgery, The C. V. Mosby Co.)

characterized by increased tendency to bleed. Excessive hemorrhages may be produced by trivial injuries. Sometimes the bleeding is into joint cavities (hemarthrosis). The underlying pathology is unknown; somehow the blood is unable to clot in the normal manner.

THE GASTROINTESTINAL TRACT

Introduction.—Many of the diseases of the digestive tract produce similar symptoms and signs. The differential diagnosis depends upon the history, clinical course, and information obtained from special laboratory procedures. Often physical signs are absent in the early stages of disease and do not appear until the condition has become advanced. This is especially the case in the various forms of cancer of the abdominal organs. Physical findings are frequently absent in peptic ulcer, early cancer, gastritis, and intestinal neuroses.

Tenderness and Muscle Spasm.—Two of the most important signs of gastrointestinal disease are abdominal tenderness and muscle spasm. Both may be localized or general in the abdomen. Tenderness may be misleading, as it depends upon the patient's threshold to pain. Rebound tenderness is pain obtained when the examining fingers are suddenly released from deep pressure on the abdomen Tenderness or pain produced by palpation is usually a sign of inflammation of the peritoneum. Many exceptions may exist; for example, epigastric tenderness found in uncomplicated peptic ulcer and gastritis. This may be no more noticeable than the discomfort felt in normal persons who are highly sensitive Tenderness can be elicited from any part of the abdomen in patients who are suffering from severe emotional upset with digestive tract symptoms.

Muscle spasm of the abdominal wall muscles is due to increased tension of the muscle fibers Voluntary muscle spasm is common among patients who are unable to relax It rarely precedes tenderness as a sign of gastrointestinal disease. When it does, it is usually associated with a disorder involving the muscle itself, such as myositis

Superficial tenderness of the skin can readily be differentiated from peritoneal tenderness by gently pinching or stroking the skin.

of the heart, and low-grade fever. This disease may be confused with rheumatic heart disease because of the cardiac findings.

When the membrane surrounding the red blood cells is destroyed by bacterial toxins and such chemicals as methylchloride or benzol, anemia develops (hemolytic anemia). Jaundice, enlarged spleen, and pallor are the common findings.

Polycythemia Vera.—An abnormal increase in red blood cells in the blood (polycythemia vera) produces an enlarged spleen and gives the skin a reddish-purple hue. Following hemorrhage, there is a physiological increase in the number of red blood cells (hemoconcentration) because of the increased concentration of the fluid portion of the blood.

Leukopenia.—An abnormal decrease in the number of white blood cells (leukocytes) in the blood is called leukopenia. Leukopenia occurs in a large number of diseases. Some of the diseases in which leukopenia is commonly present are measles, malaria, cirrhosis of the liver, and influenza.

Leukocytosis.—An abnormal increase in the number of white blood cells in the blood is called leukocytosis. There are two types. (1) the symptomatic or secondary form occurring in such infections as pneumonia and scarlet fever and (2) the primary form which is called leukemia. Leukemia may involve any of the several types of white blood cells. The most common forms of leukemia are the myeloid (neutrophile) leukemia, lymphatic (lymphocyte) leukemia, and monocytic (monocyte) leukemia. In general, the signs are moderate fever, enlarged liver, spleen, and lymph nodes, and bleeding from the gums. The liver and spleen usually show a slight enlargement. The liver edge is smooth, nontender, and firm and extends below the margins of the right ribs. The spleen is smooth, nontender, and firm and extends below the margin of the left ribs. In the early stages of leukemia the lymph nodes are small, round, firm, movable, and nontender As the disease progresses, they enlarge and may become matted together.

Hemophilia.—Hemophilia is a rare hereditary disease transmitted through females but occurring only in males. It is

high obstruction of the small intestines than in a low obstruction of the colon. The vomitus is usually foul smelling. A fecal odor is a sign that the obstruction is in the colon. The patient appears prostrate. The pulse is rapid and the temperature subnormal, and the skin of the extremities is cold, pale, and cyanotic. With prolonged obstruction the blood pressure decreases. A tender mass may become palpable at the site of obstruction. The most common causes of intestinal obstruction are volvulus, adhesions, strangulation of hernias, and occlusion of the mesenteric artery.

Ascites.—Ascites is an abnormal accumulation of fluid in the peritoneal cavity. In acute ascites the abdomen rapidly increases in size, appears tense, and is globular in shape. When fluid accumulates slowly, the abdominal wall has time to stretch, and the signs are less pronounced The fluid in the peritoneal cavity will shift with the movement of the patient since it follows the law of gravity Tapping the abdomen with the hand produces a fluid wave which can be felt by the examiner.

Hemorrhage.—Bleeding from the gastrointestinal tract is indicative of a pathological lesion somewhere in the tract If mixed with feces, the blood may be bright red or altered in color. Blood coming from high up in the intestinal tract produces black, tarry stools (melena). This is seen in cancer of the stomach and peptic ulcer Blood coming from the lower ileum or colon is red, as, for example, in ulcerative colitis. Certain medicines such as charcoal, iron, and bismuth will produce gray-black stools which may confuse the diagnosis.

Vomiting of blood (hematemesis) may or may not come from the stomach. It must be distinguished from hemorrhage occurring in the lungs which produces bloody sputum (hemoptysis). In cirrhosis of the liver or splenic anemia, the veins of the esophagus may become varicosed and bleed. The blood may be vomited fresh or pass into the stomach and become partly digested If it is then vomited, it will be black and resemble coffee grounds Some causes of gastric hemorrhage are acute gastritis, cancer, and peptic ulcer.

Jaundice.—Jaundice (icterus) is a yellow discoloration of the tissues It is due to the presence of an excessive amount of bile or bile pigments in the blood The degree of jaundice

In acute appendicitis tenderness and pain may first be felt in the epigastrium and later in the right lower quadrant, where it becomes localized. When the appendix becomes gangrenous, rebound tenderness and muscle spasm appear. If the appendix ruptures and peritonitis develops, it may remain localized or it may spread throughout the abdomen and become generalized. When this happens, the abdominal wall becomes rigid and boardlike, with generalized tenderness and pain. This holds true in cases of ruptured organs (liver and spleen) or perforated hollow viscus (stomach and intestines).

Inflammation of the large intestine (colitis) can produce generalized tenderness or tenderness localized to any of the four abdominal quadrants

A palpable mass is a sign of tumor (benign or malignant), abscess, inflammatory mass (appendiceal abscess), or distention of a hollow viscus (stomach) with gas, fluid, or solid material Many normal structures beneath the abdominal wall, such as the liver, kidneys, or abdominal aorta, are palpable. Tenderness of a mass generally indicates inflammation. Hard masses disappearing after an enema and defecation are usually due to impacted feces A soft, pliable, tympanitic mass relieved by belching or gastric tube indicates distention of a hollow viscus, the stomach or intestines, with gas.

Peristaltic waves of the digestive tract may normally be visible in patients with a thin abdominal wall. These waves cannot be felt by the patient. When the lumen of the intestines becomes obstructed, the intestinal contents in front of the obstructive lesion (tumor or adhesions) cannot pass through to the lower end of the tract The onset of the symptoms and signs of an intestinal obstruction is sudden The earliest sign is severe cramping pain localized in the epigastrium or near the umbilicus. There may be relief of pain between the attacks, but it is not complete. The patient will roll from side to side, holding his legs in a flexed position. The cramps are aggravated by ingestion of food or laxatives. If the obstruction is not removed, the bowel becomes distended and the abdomen appears swollen, giving a tympanitic sound on percussion. The abdomen is very tender to touch. Sometimes the distended loops of bowel will show an intestinal pattern with an increase in the peristaltic movement that is visible on the surface of the abdominal wall. Vomiting is more common in

perinephric abscess, bulging of the costophrenic angle may occur. With abscess formation localized in the kidney, the body may be curved toward the affected side to relieve the pain. A "cold" abscess from tuberculosis may reveal itself by a bulging mass in the loin. Such a mass is not tender.

Kidney Enlargement.—The most frequent causes of kidney enlargement are malignant tumors, polycystic disease, hydronephrosis, and abscess formation.

It is difficult to determine abnormally small kidneys by physical examination. If only one kidney is smaller than normal it indicates either congenital aplasia or atrophy resulting from disease. If both kidneys are small, it usually means chronic pyelonephritis.

Chills and Fever.—Chills and fever in the presence of renal findings indicate inflammatory disease of the urinary tract such as pyelitis or cystitis. Low-grade fever may occur in renal tuberculosis

Uremia.—If disease of the kidneys is allowed to progress, renal function becomes impaired and uremia may develop. The physical findings of uremia are varied. The most common signs are stupor, convulsions, restlessness, muscular twitching, edema, hypertension, and retinal hemorrhages. The odor of the breath may be ammoniacal due to the excess of nonprotein nitrogen in the blood A rhythmic type of breathing (Cheyne-Stokes breathing) is common The elevation of blood pressure is usually not quite so high as that found in essential hypertension. When uremia is severe the heart may be found to be enlarged, and the symptoms and signs of heart failure may appear. Heart failure is usually due both to the renal insufficiency and the elevated blood pressure A moderate fever is common The skin usually appears pale due to a progressive anemia that develops as a result of the toxic effect on the bone marrow.

Edema.—Edema appears during some stage of most types of nephritis The loose subcutaneous tissue of the eyes may be the first to show puffiness. Later edema involves the ankles, legs, and the external genitalia In the terminal stage general anasarca with ascites may develop.

Bladder Distention.—A distended bladder appears as a smooth, firm, round, fluctuant, tender mass beneath the ab-

depends upon the amount of bile in the blood. When the amount is small, no discoloration of the skin is seen. The increase in bilirubin in the blood can at first be detected only by chemical analysis. As the amount of bilirubin in the blood increases, the skin will change from a pale yellow to yellow-green to dark orange. A lemon-yellow tinge of the skin is usually found in patients ill with pernicious anemia. The most common causes of jaundice are damage to the liver and obstruction of the common bile duct.

THE GENITOURINARY TRACT

Introduction.—The signs of urinary tract diseases found during physical examination are usually not outstanding. Frequently, special laboratory tests, x-ray studies, and cystoscopy are needed to make a diagnosis In many cases a systemic change (edema, fever, and chills) is the first evidence of kidney disturbance as occurs in pyelitis or nephritis.

Blood, pus, gravel, or cloudy urine are the most important signs of urinary tract disease. These attract attention to the presence of some abnormality in the kidneys, uterus, bladder, or urethra Hematuria (bloody urine) usually means serious disease. The urine of glomerulonephritis is "smoky" due to the mixture of red blood cells and urine. Bleeding that is present throughout urination may arise from any portion of the urinary tract. Bleeding that occurs at the onset of urination originates in the urethra Bleeding at the end of urination suggests a lesion in the bladder such as cystitis or cancer. In most cases, bleeding means the presence of a stone or tumor or tuberculosis.

Tenderness.—Abdominal or back *tenderness* elicited by palpation is of little significance in determining the presence of disease of the kidneys. A *normal kidney or bowel distended* with gas lying near the kidney may both be tender to palpation. With kidney or urethral stone, tenderness may be present along the course of the ureter or over the costovertebral angle. Anatomically the right kidney lies lower than the left and is easier to feel. The left kidney is more difficult to palpate. Acute infection of the kidney or the perirenal structures causes local tenderness and pain. In chronic renal disease, tenderness is less marked. With tumors, abscesses of the kidney, and

matoid arthritis affects multiple joints and most commonly involves the proximal phalangeal joints of the fingers Arthritis involving the spine, hips, and shoulders is called Marie-Strumpell's disease. In the late stages of rheumatoid arthritis the joints become fixed (ankylosed) and the muscles of the extremities atrophy. The outstanding signs are the long, spindle-shaped fingers associated with swelling of the interphalangeal joints of the fingers and ulnar deviation of the hands. Rheumatoid arthritis in children is called Still's disease.

Hypertrophic arthritis is a chronic disease involving multiple joints. Signs of acute arthritis are absent. It does not produce ankylosis but on x-ray examination the bones show small spurs at the ends. It most frequently involves the terminal interphalangeal joints of the fingers and the larger joints. As the disease progresses, small, hard, fixed bone growths may appear at the terminal interphalangeal joints of the fingers (Heberden's nodes).

The arthritis of rheumatic fever is migratory, involving one joint after another. However, several joints may be involved simultaneously. The joints will show the typical signs of swelling, tenderness, etc., but with treatment and bed rest they subside. There is no residual joint damage.

Abnormal skeletal development in children is due to endocrine disturbance (achondroplasia) or vitamin deficiency (rickets). In young adults softening of the bones (osteomalacia) is associated with vitamin D deficiency This disease is more common among women, especially during pregnancy and lactation Osteitis deformans (Paget's disease) is more common among middle-aged males. There is generalized enlargement of all of the bones with kyphosis.

The most common disorder of the muscles is muscular rheumatism. This is due to inflammation of the fibrous tissue. Acute rheumatism occurs after long exposure to dampness and cold. When it is severe, the muscles become tender and spastic. An abscess of the muscle shows signs of tenderness and swelling limited to the zone of inflammation.

Small, hard, bony masses in the fibrous tissue of the muscles are signs of a rare disease called myositis ossificans.

The Endocrine System.—Disorders of the endocrine glands play an important role in the production of various abnormalities of stature, the muscles, skin, and nutrition. Endocrine

dominal wall extending above the pubis. Diseases of the bladder (tumor, cystitis) produce very few signs.

External Lesions of Syphilis.—The external lesions (ulcers) of syphilis may appear on the glans or on the shaft of the penis. In the female, they are found on the labia or vaginal mucosa.

Absence of Testes.—The absence of testes in the scrotum indicates failure of their descent from the abdominal cavity, through the inguinal rings, into the scrotum.

Varicocele; Hydrocele; Spermatocele.—A mass of dilated veins felt in the scrotum is called a varicocele. The most common cystic masses of the scrotum are the hydrocele and the spermatocele. These tumors are fluctuant and transmit light. To test for transmission of light, the room must be darkened. A flashlight is held against the scrotum next to the tumor mass. If translucent, a diffuse pinkish glow will appear; this will indicate that the mass contains fluid rather than solid tissue.

THE MUSCULOSKELETAL AND ENDOCRINE SYSTEMS AND THE SKIN

The Musculoskeletal System.—The symptoms and also the signs of diseases of the joints are pain with limitation of motion, swelling, and heat and redness over the involved joint or joints. The pain is usually localized and relieved by immobilization. If joint swelling is severe, pain will be present at rest. If fluid is present to excess in the joint cavity, fluctuation may be demonstrated; otherwise the swelling may be of the ligaments and other structures surrounding the joint. In rheumatoid arthritis fluid is absent In the acute stages of arthritis, heat and redness are always found. If the disease becomes chronic, these signs disappear but pain and swelling may remain In chronic noninfectious arthritis, such as rheumatoid arthritis, muscle atrophy results from lack of use of the extremities.

Arthritis may affect a joint singly or involve many joints. Infectious arthritis (pyogenic, gonococcal, streptococcal) more commonly affects the knees, ankles, and wrists. Tuberculous arthritis, as a rule, is monarticular, but it may be polyarticular The hips and the spine are the joints usually involved Rheu-

increase in hunger and appetite (polyphagia). As the disease progresses, there is an increase in weight and a decreased tolerance for skin infections such as boils and fungus infections (*Monilia albicans*). The deep reflexes in the lower extremities may be absent (peripheral neuritis). Examination of the urine will be positive for sugar (glycosuria). In uncontrolled diabetes the patient may develop acidosis due to the excessive accumulation of acetone bodies (acids) in the blood. When severe, the patient becomes comatose (diabetic acidosis). His breath has the odor of acetone. The urine will give a positive test for acetone bodies. However, the actual signs on physical examination may be limited to emaciation and various skin lesions.

Hyperfunction of the parathyroid glands (hyperparathyroidism) produces marked shortening in stature with extensive skeletal deformities due to calcium depletion. Pathological fractures, kyphosis, and narrowing of the pelvis are common.

The Skin.—The most common sign of skin disorders is a rash which may be localized, as in contact dermatitis, or extensive, as a manifestation of some systemic disease such as furunculosis (boils) complicating diabetes. It may be generalized as in measles. The pathological process of skin lesions usually assumes some distinct characteristic. They may be of any size, color, or shape and be in different stages of growth or regression. Some skin diseases are characterized by an original lesion which is called the primary lesion or the herald lesion. It may differ entirely from the secondary rash which occurs later.

Primary lesions are macules, papules, nodules, wheals, vesicles, pustules, bullae, and tumors. Macules are flat, circumscribed lesions of various sizes, such as bruises and freckles. Papules or pimples are solid elevations without fluid as seen in acne papules. Nodules are small tumors in the subcutaneous tissue such as the tophi of gout Wheals are edematous, flat elevations usually oval in shape and seen in allergic conditions. Vesicles are small blisters and contain fluid. Bullae are large blisters. Pustules are small elevations containing pus and are seen in smallpox. Tumors are soft or hard, freely movable or fixed masses such as lipoma.

The *secondary lesions* are scales, excoriations, fissures, crusts, ulcers, and scars. Scales are dry masses of epidermis.

gland disease may affect the entire body, as in dwarfism and gigantism (pituitary disorders).

The objective skin changes are those of color, pigmentation (diffuse or localized), and hair growth. In myxedema (hypothyroidism) the skin is dry and thick; in acromegaly (hyperpituitarism) the skin is dark and thick.

Disturbances of hair growth may be signs of endocrine disturbances. Loss of hair on top of the head, with overgrowth of hair on the arms and legs, is a common finding in acromegaly. The reverse of this in males—a heavy growth of hair on the scalp with absence of hair on the face, trunk, arms, and legs—suggests underactivity of the male gonads. Overgrowth of hair on the face, particularly in the female, is associated with disorders of the adrenal cortex (adrenal virilism).

Extreme disorder of the thyroid gland (hyperthyroidism) produces protrusion of the eyeballs (exophthalmos). Thick eyelids and frequent squinting of the eyes occurs in myxedema (hypothyroidism). Abnormality of the nasal bones, such as a short nose, may result from congenital hypothyroidism. Malformation of the mouth may be related to endocrine disturbances during childhood such as delayed eruption of the teeth in hypothyroidism and small teeth resulting from overactivity of the pituitary gland.

The most frequent abnormality of the genitalia is underdevelopment, as occurs in hypopituitarism. In the male, the testes and penis are smaller than normal in proportion to the age of the patient. In the female, a small pin-point cervix with abnormally small uterus is found on vaginal examination.

Premature sexual development (pubertas praecox) occurs with tumors of the pineal body, the suprarenal cortex, and the testes. The penis may enlarge, and pubic hair and a deep voice may appear long before puberty. The testes may fail to descend into the scrotum and remain in the abdominal cavity (cryptorchidism).

Pubertas praecox in girls is characterized by early onset of menstruation, enlargement of the breasts, and growth of pubic hair. It occurs in ovarian tumors of the granulosa-cell type.

Diabetes mellitus results from a disturbance in the pancreas. Early in the disease the patient complains of fatigue, abnormal gain of weight, excessive thirst (polydipsia), and

pigmented skin; if injured or irritated, they may become malignant. The "birthmark" or "port-wine mark" is a congenital vascular mole.

STUDY QUESTIONS—UNIT III

1. What is a *symptom?* a *sign?* Give examples of each
2. What are some of the characteristics of pain?
3. What is the difference between a functional and organic disorder?
4. Describe and give the significance of some of the common symptoms of the nervous, the respiratory, the cardiovascular, the gastrointestinal, the genitourinary, the musculoskeletal and endocrine systems, the head and neck, the blood and blood-forming organs, and the skin
5. How does the body react to injury?
6. Discuss important signs of the nervous, respiratory, cardiovascular, gastrointestinal, genitourinary, musculoskeletal, and endocrine systems, head and neck, the blood and blood-forming organs, and the skin

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Scaling of skin occurs after scarlet fever and sunburn. Excoriation is displacement of the superficial skin tissue. This lesion is most commonly caused by scratching, as in scabies and eczema. Fissures are cracks in the skin as occurs with severe "chapping." Crusts are dried masses of pus and serum as in smallpox lesions. Ulcers are destructive excoriations of the skin as are seen in cancer. Scarring is formation of new connective tissue replacing the tissue lost from injury or disease.

Looseness of the skin is common in old people and is due to loss of elasticity of the superficial structures in the skin. In young individuals it indicates recent loss of weight. Normally the skin is moist during warm weather and after exertion In infectious diseases with high temperature the skin is very damp and wet. If the fever is prolonged, the skin becomes dry (dehydration). A cold, clammy skin may be a sign of peripheral circulatory collapse. In myxedema, old age, and diabetes the skin is abnormally dry.

Thinning of the skin (atrophy) may be generalized, as in old age, or localized, as around arthritic joints. Striae are pinkish lines seen over the abdomen and the hips during pregnancy and in obese individuals.

Hypertrophy, or thickening, of the skin is found in myxedema, moles, and corns.

Changes in the color of the skin (pigmentation) may be general or local, depending on the cause. Congenital absence of pigmentation (albinoism) gives a white or pinkish skin. Pigment-free areas surrounded by areas of darker skin is called vitiligo. Increased pigmentation is common in the folds of the skin (axilla) and on the exposed skin of the hands and face. A generalized yellow-brown pigmentation of the skin is associated with Addison's disease, diabetes, and the late stages of cancer. Darkening of the nipples and areolar tissue of the breasts during pregnancy is a normal physiological change. In brunettes the skin may be darker. Exposure to the sunlight, cold, and heat will produce a temporary redness of the skin. Patchy light brown discoloration of the skin is often a sign of healed skin lesions. Scars are often pigmented.

The most common malignant tumor of the skin is the epidermoid carcinoma. The most frequent benign lesion is the verruca (wart). Moles are brown, raised, circular areas of

cardiography, basal metabolism tests, and blood chemistry determinations. The information thus obtained, however, is of little value unless the examiner is familiar with the various diseases and their manifestations, The laboratory tests do not in themselves furnish the diagnosis. One must be able to assign to each piece of evidence its relative importance in order to make a diagnosis. It is obviously important that a correct diagnosis be made early in order that treatment may be started before the disease is advanced.

The nurse may be of valuable assistance to the physician. By her close contact with the patient she has an opportunity to study the patient, which may be most valuable. By reporting her findings to the doctor she can greatly aid in making the correct diagnosis. An alert nurse will keep concise, detailed notes on the patient's clinical chart. These notes can be invaluable to the doctor if they contain pertinent, accurate details. Too often they represent lost opportunities by being trivial or by missing important data

In determining the nature of a disease the doctor may use one or more methods of diagnosis. Sometimes the diagnosis can be made from the patient's history. A patient who has angina pectoris will complain of a peculiar distress or aching in the chest which is so characteristic that it alone suffices for the diagnosis. Frequently the patient will describe this discomfort as indigestion instead of pain. It is most commonly located in the center of the chest, and rarely over the precordium and apex of the heart. It may arise in the epigastrium, chest, or neck, and characteristically radiates down the arm. The radiation is more common in the left than the right arm The descriptive terms used by the patient are important. Some will experience tightness in the chest, a burning sensation, or a feeling of fullness Frequently the discomfort is so mild the patient hesitates to call it pain The distress has a sudden onset, especially on exertion. Walking is the most common form of activity to bring on a spell of distress Next to physical effort is mental excitement in bringing on the pain. The distress may also occur after a full meal or exposure to cold weather. In many other disorders also the history furnishes the most important evidence for the diagnosis.

Physical Diagnosis: This is made from the objective signs of a disease found by physical examination through the means

UNIT IV

HOW THE DOCTOR MAKES THE DIAGNOSIS (DIAGNOSTIC PROCEDURES)

Units II and III lay the foundation for the understanding of his material, and only if they have been mastered thoroughly will the student get the full significance of diagnostic procedures. Particularly will the knowledge of physiology, chemistry, and bacteriology be necessary in learning about the physical examination and laboratory diagnosis. From *nursing* rts the student has learned or is learning her responsibility 1 the different tests. For quick reference to the normal and athological significance of the tests described in this unit, the udent is referred to pp. 338-359.

HAPTER 15

ISTORY

Introduction.—Diagnosis is the art of determining the nature a disease from its symptoms and signs. Symptoms are bjective and are described by the patient through the course history taking. Signs are objective, and these the physician covers during his physical examination. In some *instances*, diagnosis is obvious and made without difficulty, but so iny diseases have similar symptoms and signs that the ignosis may be very difficult. Then the physician may use ecial methods of examination such as x-ray studies, electro-

X-Ray Diagnosis: This is made by use of the x-ray machine and the fluoroscope. When the x-ray machines are in operation, invisible beams of electrons (x-rays) are produced. These have the power to penetrate soft tissues such as lungs and muscles but are stopped by opaque objects such as bones,



Fig 31—Visualization of a normal bronchial tree with Lipiodol. (Courtesy Edward Mallinckrodt Institute of Radiology, Washington University School of Medicine, St Louis)

metal, and large solid organs as the liver and spleen. Hollow organs which ordinarily are invisible can be filled with radiopaque material that will stop the x-rays. In order to study hollow organs, special liquid preparations are used that con-

of inspection, palpation, percussion, and auscultation. These will be discussed in greater detail in Chapter 16.

Differential Diagnosis: This is the act of deciding which of two or more diseases with similar symptoms is present in a given case.

Diagnosis by Exclusion: This is made by excluding one by one those diseases which must be considered in view of the evidence, thereby leaving only one disease which fits best the signs and symptoms which are present. For example, a patient suffering from swollen, painful joints may have one of various forms of arthritis such as rheumatoid or gonococcal arthritis. The typical symptoms, signs, and laboratory findings and clinical course of each disease are compared with those present and if they do not fit the case it is eliminated. If a diagnosis cannot be made on the basis of the patient's history and physical examination, a tentative diagnosis only is made. This diagnosis is temporary and used as a working basis until the final diagnosis is made.

Laboratory Diagnosis: This is made by a chemical, microscopic, or bacteriological study of the various body tissues, secretions, and discharges. Frequently laboratory examinations are necessary in order to make a diagnosis or to eliminate certain diseases. This is best illustrated by a patient suffering from kidney disease The most common chemical tests used are the determinations of nonprotein nitrogen (N.P.N.), urea, and uric acid in the blood. Kidney function may be studied by various tests including the phenolsulfonphthalein (P.S.P.), the urea clearance test, and many others.

Pathological Diagnosis: This is made by observing the gross or microscopic changes in diseased tissue. For example, a malignant lesion such as carcinoma of the lip has certain gross characteristics that differentiate it from other lesions that may appear on the lips. However, benign lesions may resemble it. To be sure of the diagnosis, a small piece of living tissue is excised from the lesion. This process is called biopsy.

Serum Diagnosis: This is made by the use of serological tests such as the Wassermann and Kahn tests for syphilis and the agglutination tests for undulant fever and typhoid fever.

cation, and exertion; the nature of their onset and cessation, whether sudden or insidious, intermittent or continuous; how long the symptoms have been present; and what aggravates or relieves them. For example, pleural pain usually appears in the lower part of the chest, has a sudden onset but is of short duration; it may or may not be associated with an upper respiratory infection, and it is aggravated by cough and deep inspiration. After a good, detailed history has been taken, the doctor often considers a number of possible diagnoses.

Leading questions should be avoided as patients may subconsciously tend to answer questions the way they think the doctor wants them to.

Family History: This part of the history can be very important. It should contain data on the mother, father, grandparents, brothers, sisters, and children — their ages, whether they are dead or alive, their state of health if alive, and the cause of death if dead. Many diseases such as peptic ulcer, diabetes, migraine headache, angina pectoris, coronary heart disease, hypertension, nephritis, hemophilia, and allergic disorders tend to run in families. The history of tuberculosis in the family is important from the standpoint of contact infection. If there is a hereditary disease in the family, such as hemophilia, detailed study of the health of the grandparents, aunts, uncles, and cousins should be made.

Past History: Past history begins with the birth of the patient and includes the story of his life up to the onset of the present illness. It is needless to say that this constitutes a valuable part of the record. Some adults, especially elderly people, have difficulty in remembering all that has happened to them. Mothers or fathers can give the history for their children. A history of residence in the tropics in a patient should bring to mind the various tropical disorders to which he may have been exposed The general state of health and strength up to the present illness should be obtained. Has the patient been strong and active in outdoor life such as fishing, hunting, and other sports, or has he led a quiet indoor life because of frailness?

A record of previous diseases is next obtained and should include all his symptoms. The patient should be questioned about all acute infectious diseases such as measles, mumps,

tain barium or iodine. Lipiodol is such a preparation which is used to examine the air passages in the lungs. The x-rays which penetrate the body are made to strike a special type of film on which they have a photographic effect, leaving a "negative" film or print on which densities appear white opaque and the tissues through which the rays pass appear black or gray. The fluoroscope consists of a sensitive screen that is movable and may be placed over the patient's body to study the opaque structures that become visible in outline when they stop the rays. Its most valuable use is in the study of the lungs, the size and shape of the heart, and, after the ingestion of barium, the peristaltic waves and outlines of the stomach and intestines. The picture produced on the x-ray film is kept as a permanent record, while that produced by the fluoroscope is only seen while the machine is in operation.

History.—A well-taken history is a most important part of the diagnosis. To obtain a good history the patient must be made to feel at ease and realize that the answers he gives to the doctor's questions are for his own benefit and are not to satisfy idle curiosity. The value of the history depends upon the veracity and intelligence of the patient and the astuteness of the doctor. A good history must be accurate and specific. All previous illnesses must be given by name with a description of their symptoms. All information given by the patient must be accurately dated.

Present Illness: Generally the patient prefers to discuss first the symptoms that brought him to the doctor. The "present illness" is the history of the present symptoms up to the time the patient presents himself to the doctor. The patient should first be allowed to describe his symptoms in his own words, but his data should be kept in chronological order. The history should also include the patient's name, age, date of birth, and record of other complaints and their duration, including the time and nature of their onset, as well as previous illnesses. Many diseases have similar symptoms, which, however, vary more or less, depending upon the disorder. They must therefore be studied in great detail to bring out all their fine points The doctor must know the location, intensity, and quality of any abnormal sensations. He must know how the symptoms are related to such bodily functions as eating, sleeping, defe-

chitis, and primary atypical pneumonia (virus pneumonia), or productive as in tuberculosis or lobar pneumonia. The characteristics of the sputum must be described carefully. It is significant if the sputum was clear in color or green or black, or if it contained blood.

In reviewing the cardiovascular system the patient is asked if he has experienced shortness of breath (dyspnea), throbbing of the heart (palpitation), and any abnormal sensations beneath the sternum or near the heart. Dyspnea may arise from other causes than heart disease; for instance, pulmonary diseases (pneumonia). The cardiac patient becomes short of breath on a degree of effort that usually fails to produce discomfort. Attacks of dyspnea may occur at night when the patient lies asleep (cardiac asthma), and relief is obtained by sitting in the upright position (orthopnea).

Palpitation of the heart does not necessarily indicate heart disease. It occurs frequently in thyrotoxicosis, fatigue, and cardiac irregularities such as extrasystoles.

Precordial pain of cardiac disease (angina pectoris) may be severe and radiate to various points on the chest or into the arms. Substernal pain or oppression may be mild or severe. In general, it indicates insufficiency of the coronary arteries.

History of gastrointestinal disturbance should be explained in lengthy detail, for often the details reveal the diagnosis. Symptoms of esophageal difficulties are choking, pain, difficulty in swallowing, and immediate regurgitation of food. Organic diseases of the stomach may produce nausea, vomiting, belching, fullness, epigastric burning, and loss of appetite and weight. These symptoms will vary from patient to patient, depending upon the patient's ability to express himself. Intestinal disorders may be organic or functional. Symptoms of constipation may be due to irregular bowel habits, lack of exercise, or a slowly progressive intermittent obstruction of the bowel Diarrhea is usually caused by some pathology within the intestine. The examiner is interested in the color, number, and form of the stools The black-colored stool of massive hemorrhage, the clay-colored stool of obstruction of the common bile duct, the watery stool of diarrhea, and the dry, hard stool of constipation each constitutes important evidence. The presence or absence of pain during a digestive upset should be noted.

whooping cough, scarlet fever, typhoid fever, pneumonia, rheumatic fever, tonsillitis, and malaria. If other less common infections are mentioned, *specific statements concerning* them should be made and further detailed history ascertained. The duration, severity, and complications of any disease should be recorded. A record is made of all inoculations such as vaccination against smallpox or typhoid fever, immunization with diphtheria and tetanus toxoid.

A history of previous operations such as appendectomy and of injuries to any part of the body should be recorded.

An inquiry should be made about asthma, hay fever, hives, and skin disorders such as eruptions, itching, sweating, and pigmentation.

A review of all the systems is next obtained, beginning with the head. Few symptoms are more difficult to interpret than headache because several hundred causes have been described. For example, headache may be associated with such diseases as meningitis, syphilis, heart disease, disturbance of vision, and sinusitis. The doctor must obtain information about the eyes, ears, nose, throat, and teeth. He wants to know if the patient has had double vision (diplopia) or any inflammatory disease that caused itching, burning, or redness of the eyes; if he has had any nasal obstruction, nosebleeds (epistaxis), the frequency of head colds; if he has had any discharge from the ears, earache, loss of hearing, or ringing (tinnitus); if he has had any bleeding from the gums, abscesses, or extractions; if he has had tonsillitis, sore throats, or hoarseness.

It is important to know what enlargements have been present—swelling of the neck glands, such as swollen lymph nodes, enlargement of the thyroid, or lumps in the breasts.

The symptoms arising from the respiratory system are not many, but a thorough, detailed inquiry is made concerning disturbance in speech (hoarseness, loss of voice), stridor (crowing-like sound during inspiration), cough, expectoration, dyspnea, cyanosis, pain in the chest, nightsweats, and hemoptysis (spitting up of blood). In general, alterations in the voice may be due to lesions on the vocal cords, hysteria, or paralysis of the vocal cords. Stridor represents obstruction in the epiglottis or larynx, or trachea during the inspiration phase. The cough may be dry and nonproductive as in tracheitis, *bron-*

Social History: Social history should reveal data concerning the patient's background such as schooling, education, personal relations, business life, sexual experiences, recreational activities, social life, and his general adjustments to his surroundings This information gives the doctor the opportunity to evaluate the emotional status of the patient and to understand better why he is seeking medical aid.

Habits: This part of the history concerns the daily routine of the patient. Information about rest, diet, regularity of eating, exercise, and consumption of milk, tea, coffee, tobacco, drugs, or medicines including sedatives or sulfonamides, is important. Functional disturbances particularly may depend upon some abnormality in the patient's method of living.

Occupational History: A number of factors in the occupation of the patient may influence his health. Exposure to heat, cold, or dust or exposure to metals such as lead, benzol, arsenic, and poisonous gases may be important. Storage battery workers, painters, plumbers, and rubber and leather workers may unknowingly be employed under dangerous conditions or, if careless, be exposing themselves to health hazards.

At the end of the history a note should be made as to whether the history was obtained from the patient, friend, or relative. It is a good practice to make a note of the mental condition of the patient and the reliability of the history.

In the routine of hospital or office practice, it is, of course, *impossible and unnecessary to cover every point here mentioned* in detail Judgment should guide the history taking and in individual cases emphasize and enlarge upon the pertinent facts. However, in order to take a good history, it is necessary that the examiner know all the different aspects of history taking and how to apply them to each case.

To obtain a history of disturbance of the genitourinary system requires diplomacy and tact on the part of the doctor, for many patients are reluctant to discuss these symptoms. Frequency of urination may indicate irritative lesions of the renal pelvis or bladder. An increase in volume of urine (polyuria) may suggest diabetes or glomerulonephritis (Bright's disease). The history of bleeding (hematuria) suggests pathological changes of tumor or tuberculosis. Pain, if present, may be dull across the back, as in chronic kidney disease. The patient is asked if he has ever had swelling (edema) of the ankles which might suggest kidney disease. History of puffiness under the eyes may also indicate kidney disease.

Both men and women should be asked if they have had or been exposed to venereal disease (gonorrhea or syphilis) and if they have had any discharge from the genitalia. In women, inquiry is made about the menstrual history—the age of onset, regularity and the duration of the periods, the amount of bleeding, and whether it is accompanied by pain (dysmenorrhea). If the patient is past the age of the menopause, it is important to know if or when menstruation ceased. Unusual bleeding at and after middle age suggests cancer of the uterus or cervix.

In reviewing the nervous system a clear picture of the sequence of unusual events should be ascertained. Symptoms related to the head are headaches, ringing in the ears, dizziness. Nervous symptoms of the extremities are numbness, tingling, pain, tremors, and difficulty in motor function.

A history of loss of weight may suggest organic disease of the thyroid gland, cancer, or disease of the gastrointestinal tract. Unusual gain in weight occurs in disease of the kidneys or heart because of edema.

Marital History: This includes data concerning the health of the wife or husband, the number of children and their health, miscarriages and pregnancies, and the presence of infections within the family, with particular reference to tuberculosis, syphilis, and gonorrhea. If difficulties in the marital union exist, sexual and domestic happiness should be investigated. If the family is poor, dietary factors and living conditions may be the cause of bad health. Financial difficulties may be responsible for dietary, nutritional, and emotional disorders.

By the oral method the thermometer is placed in the mouth, under the tongue, with the lips closed, and held for at least three, preferably five, minutes. The mercury in the thermometer must be shaken down below the etched arrow mark on the glass before it is used. Mouth breathing and recent use of hot or cold liquids in the mouth will give a false reading. The normal temperature is 98.6° Fahrenheit. Alterations in normal physiological body functions as occur after eating, exertion, and defecation may give readings from 97.0° to 99.0° F. If the temperature is over 99.0° F., fever is said to be present. Moderate elevation of temperature in children is less important than in adults. Hysterical patients or malingerers may falsify readings by heating the thermometer by friction of hot applications or by shaking the mercury down.

Rectal temperature is more accurate than the oral readings. It will average 1° F. higher than that recorded by the oral method. The rectal method is used in mouth breathers, patients who are comatose or critically ill, and children and when very accurate readings are required. Patients should be closely watched while the thermometer is in the rectum because of the danger of breaking the thermometer or pushing it up into the rectum.

The axillary method is less accurate than the others and should be used only when more accurate readings cannot be obtained. It averages 1 to 2° F. below the oral observation. *Whenever possible, all temperature readings on a patient* should be taken by one method Temperature curves consisting of different kinds of readings are both confusing and incongruous.

Pulse.—The pulse is caused by the advancing wave of blood that is ejected from the heart into the arterial tree. It is not due to the forward movement of blood through the vessels The radial artery on the anterior surface of the wrist is most frequently used for taking the pulse rate because it is easy to palpate When taking the pulse, the observer places the index, second, or third finger, not the thumb, over the artery and notes the rate, rhythm, force of the wave, and the condition of the arterial wall

The normal pulse rate in adults will vary between 60 and 90 beats per minute. The pulse rate is slightly faster in women than in men In general, the pulse rate is, in most infections,

CHAPTER 16

PHYSICAL EXAMINATION

Introduction.—After the doctor has finished the history, he proceeds with the physical examination. If possible, the patient is examined first in the erect and later in a recumbent position. *When the patient is seriously ill, the examination* should be made in the position that is most comfortable to him. Male patients usually undress themselves unless the illness is critical. The nurse usually assists female patients in preparing for the examination. The patient should remove all clothing and be covered with a sheet or towel so as to expose only the region being examined. This is very important, especially for female patients. Nurses assisting in physical examinations should be well versed in the various forms of preparations. *A patient being prepared for a chest examination* is draped quite differently from one being prepared for a gynecological examination.

In clinical practice the general condition of the patient, such as the color of the skin, mental attitude, facial expression, and posture of the body, is noted while the examiner is taking the history Strictly speaking, these observations belong under "inspection," but the period of history taking may well be used for such observations and the findings entered on the patient's record

Before the doctor enters the examining room, the nurse should have taken and recorded the patient's temperature, pulse, respirations, and weight. These procedures are simple and easily done but are very valuable and informative. They are part of the patient's permanent record and may be of great diagnostic value.

Temperature.—The body temperature is obtained by three methods: oral, rectal, and axillary.

of urine and a decrease in weight. The only accurate measurement of the patient's progress as to loss of the edema is by daily determinations of his body weight. Patients ill with hyperthyroidism will give a history of progressive loss of weight with an increase in appetite. While under medication these patients should have their weight checked frequently, as one of the earliest signs of response to medication is some gain in weight. Patients suffering from cancer rarely show any change in weight as an early sign. When the lesion becomes more extensive, there is usually a slow, progressive loss of weight.

After the doctor has completed his general inspection, he proceeds to detailed examinations of the patient. He usually follows a routine plan that begins with the head and neck and continues downward to the chest, abdomen, and extremities.

Technique of Physical Examination.—Detailed physical examination includes four methods of procedure: inspection, palpation, percussion, and auscultation.

1. **Inspection** (looking at the patient): This method, when intelligently applied, may reveal most valuable information. The doctor studies the general appearance of the patient—*race, physique, nutrition. He notes whether the patient looks* well or sick, whether he coughs and how he breathes, whether he has pain, is restless, or has tremor. He observes the complexion, the color of the finger tips, texture of the skin, its temperature, whether moist or dry, and abnormalities of the growth or distribution of the hair. He looks for scars, eruptions, jaundice, edema, pigmentation, cyanosis, and gross abnormalities in the bones and the shape of the head For example, a patient with far-advanced tuberculosis appears pale and emaciated, coughs frequently, and has respiratory distress, a patient with nephritis is pale and has a peculiar puffiness of the eyelids; a patient with peritonitis is dehydrated, showing hollow cheeks, dry tongue, sunken eyes, and a pale complexion.

Close observation of the position which the patient assumes may give the necessary lead to the nature of his disease. This may be illustrated by a patient suffering from congestive heart failure who sits propped up in bed or in a chair because he

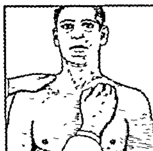
related to the temperature curve. If the temperature is elevated, the pulse rate may increase proportionately, as occurs in such diseases as peritonitis and pneumonia. In some diseases, such as typhoid fever, early meningitis, and increased intracranial pressure due to brain tumor, the pulse rate may not increase proportionately to the temperature.

Respirations.—During normal respirations the chest expands and contracts. During inspiration the ribs move downward and inward. The expansion is due to contraction of the muscles of the chest and downward movement of the diaphragm. With expiration the chest wall falls because of the weight of the muscles and bony cage. The inspiratory phase is slightly longer than expiration. The normal rate of respiration ranges between 14 to 18 per minute; in children the rate is higher—44 per minute. As the child grows older, the respiratory rate gradually decreases. The respiratory rate in women may be slightly faster than in men.

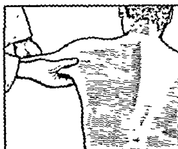
Observation of the chest during respiration may reveal numerous variations from the normal, such as diminished or increased expansion of the one side, increased rate of respirations (tachypnea) as occurs in pneumonia, increase in depth and rate of respirations (hyperpnea) as occurs after physical exercise or excitement, decreased rate of breathing (bradypnea), or cessation of respirations (apnea) as occurs in narcotic poisoning. A peculiar type of breathing in which there are periods of increased breathing (hyperpnea) alternating with irregular periods of diminished breathing is called Cheyne-Stokes breathing This is seen in nephritis, approaching uremia, severe heart disease, malignant hypertension, and increased intracranial pressure. Difficulty in breathing while lying flat (orthopnea) appears in cardiac patients with failing hearts.

Weight.—The normal weight of individuals may vary widely for the same age, height, and sex. Weight charts are to be used as guides and not as definite normal standards. Rapid gain or loss of weight may indicate the beginning of serious disease. For example, patients suffering from heart or kidney disease may develop swelling of the lower extremities (edema) and will show a marked increase in weight. Following certain medications the patient may show an increase in the output









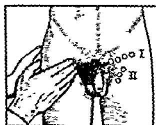


Fig. 33.—Palpation for superficial lymph nodes. (From Clendening and Hashinger Methods of Diagnosis.)



1. Inspection



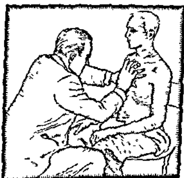
2. Palpation-the Pulse



3. Palpation - Apex



4. Palpation - Base



5. Percussion



6 Auscultation - at apex and three other spots indicated

Fig. 32.—Examination of the circulatory system. (From Clendening and Hashinger: *Methods of Diagnosis*.)

from cancer of the stomach, lung, or some other organ. The nodes are hard, discrete, and small in size.

In palpating for the thyroid gland the fingers are placed on the throat over the thyroid area and gentle pressure applied while the patient swallows. The thyroid gland can be felt to move up and down each time the patient swallows. By careful palpation the size, shape, location, and presence of masses or *irregularities can be determined.*

Placing the hand over the heart and locating the position of the apex impulse of the heart is valuable in determining the presence of enlargement or displacement of the heart. Also by palpation at the apex the doctor can determine the rate, rhythm, and character of the heartbeat.

Palpation of the arteries is frequently helpful in diagnosing such diseases as arteriosclerosis and Raynaud's disease. In *arteriosclerosis the vessels are firm and hard, can be rolled* under the finger, and are tortuous. In Raynaud's disease the large vessels feel normal, but there is a marked change in the color (redness, pallor, and cyanosis) in the fingers and hands.

3. **Percussion:** Listening to sounds produced when any part of the body is tapped in a definite manner is called percussion. The sound produced depends upon the density of the area. Certain definite sounds are heard; namely, resonance, tympany, dullness, or flatness *Percussion is used mainly in* examining the heart and lungs.

4. **Auscultation:** Listening to sounds produced by the movement of internal organs, principally heart and lungs, is called auscultation. Direct auscultation is done by placing the ear directly *on the patient's chest When the stethescope is used,* it is called indirect auscultation

Examination of the Head.—The doctor notes gross abnormalities in size and shape and the presence of tenderness, tumors, or scars. The scalp is examined for crusts and parasites, and the texture of the hair is noted. *The eyes are* examined for abnormal muscular movement, variations in the fields of vision, protrusion, arcus senilis, and drooping *of the eyelids. The retina of the eyes is checked for hemorrhage* and changes in the optic disc. The sinuses and mastoid processes are palpated for tenderness The nose is examined for discharge and obstruction. The mouth is examined for any

breathes easier in that position; the individual ill with ac abdominal disease, such as appendicitis, keeps his legs se flexed to relieve the tension of the abdomen.

The color of the skin may be yellow (jaundiced) in li diseases, hemolytic anemias, and gall bladder disease w obstruction of the common bile duct. A bluish tinge of t skin, mucous membranes, and nail beds (cyanosis) is usual due to insufficient oxygenation of the blood and occurs in heart failure and some diseases of the lungs.

Scars on the skin may indicate local injury or may be the result of an operation. Skin lesions of any kind, such as wheals of allergic disorders, may be the first sign of a systemic disease.

2. **Palpation:** Palpation is the technique of feeling the various parts and organs of the body, including pathological structures such as tumors. The doctor determines the size, shape, and consistency of the objects of examination. He is particularly interested in abnormal variations of any organ. For example, enlargement of the liver may be due to metastatic lesions from cancer elsewhere in the body; a hot, dry skin is usually a sign of high fever as occurs in pneumonia, peritonitis, and dehydration.

By palpating the various parts of the body the doctor can determine the presence of edema, changes in the skin, enlargement of the lymph nodes, enlargement of the thyroid, abdominal masses such as the liver and spleen, apex beat of the heart, and pulsations of the blood vessels. Edema is swelling of the various parts of the body due to effusion of water into the tissues. Edema due to heart and kidney disease and localized obstruction of circulation "pits" on pressure. It is painless. Edema due to hypothyroidism (myxedema) does not "pit" on pressure, and the skin feels coarse and hard. Examination for enlarged lymph nodes is best carried out in a systematic fashion. Each area (neck, axilla, groins, etc.) is examined in order. Acute or chronic inflammation of the mouth, throat, or other parts of the head and face produce enlarged, freely movable, tender or nontender lymph nodes in the neck and postauricular and occipital areas. Tuberculous lymph nodes are at first firm. Later they become soft and fluctuant. Enlarged nodes due to such diseases as leukemia are nontender, painless and freely movable and are not matted together. Enlargement of lymph nodes is frequently a sign of metastases

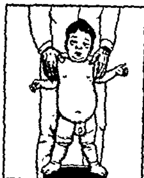
abnormalities of the teeth; the gums, for bleeding and pyorrhea; the tongue and buccal mucosa, for ulcers; the throat, for redness; and the tonsils, for the presence of exudate. The ears are examined for decrease in the range of hearing and for discharge. Also, the appearance of the membrana tympani is noted.



Fig. 35.—Exophthalmos in toxic goiter. (From Clendening and Hashinger: Methods of Diagnosis.)

Examination of the Glands.—The head, neck, axilla, elbow, and groins are examined for pathological enlargements of the lymph nodes

Examination of the Neck.—The neck is inspected for enlargement of the thyroid gland, position of the trachea in the episternal notch, venous distention, and arterial *pulsations.*



Nephritis



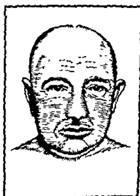
Angioneurotic Edema



Trichiniasis



Cavernous Sinus Thrombosis



Myxedema



Rupture of Aneurism of Ascending Aorta into Descending Vena Cava

Fig. 34.—Swelling of the face. (From Clendening and Hashinger: Methods of Diagnosis.)

abnormalities of the teeth; the gums, for bleeding and pyorrhea; the tongue and buccal mucosa, for ulcers; the throat, for redness; and the tonsils, for the presence of exudate. The ears are examined for decrease in the range of hearing and for discharge. Also, the appearance of the membrana tympani is noted.



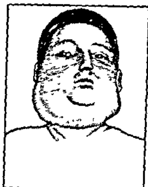
Fig. 35.—Exophthalmos in toxic goiter. (From Clendening and Hashinger, Methods of Diagnosis.)

Examination of the Glands.—The head, neck, axilla, elbow, and groins are examined for pathological enlargements of the lymph nodes.

Examination of the Neck.—The neck is inspected for enlargement of the thyroid gland, position of the trachea in the episternal notch, venous distention, and arterial pulsations.



Branchial cyst



Hodgkin's disease



Lymphoblastoma



Cervical gland enlargement due to syphilis



Cervical gland enlargement due to tuberculosis



Tumor of carotid body



Cervical gland enlargement due to tonsillitis



Metastatic cancer of cervical glands

Fig. 36.—Masses in the neck. (From Clendening and Hashinger: Methods of Diagnosis.)

Examination of the Chest.—The chest is best examined with the patient sitting or standing, stripped to the waist. The general symmetry, development, and respiratory movements are noted. Drooping of one shoulder with atrophy of the muscles, supraclavicular depression, and a contracted chest wall suggests tuberculosis. A barrel-shaped chest is seen in old age and emphysema. Beaded ribs may be a sign of rickets. The muscles of the chest and the breasts are examined for tumors. By palpation, the examiner notes the extent of respiratory movement, and the presence of vocal fremitus both in front and behind.

The chest is percussed both front and back, comparing the notes for any abnormal variation. Dullness may indicate tumor, pneumonia, or fluid. Tympany is a sign of cavity formation in the lung or of air in the pleural cavity.

On auscultation the breath sounds, voice sounds, and vocal fremitus are studied for any change from the normal Râles and friction rubs are signs of lung pathology. Râles are heard in pulmonary tuberculosis, pneumonia, and pulmonary edema due to heart failure. Sticky, musical, crackling râles are heard in asthma. Friction rub indicates inflammation of the pleura.

Examination of the Heart.—The precordium is inspected for abnormal pulsations, prominence over the heart (precordial bulge), and the apex impulse By palpation the apex impulse is localized; normally it is located in the fifth interspace within the left midclavicular line. With hypertrophy and dilatation the apex impulse may be localized in the lower interspaces and to the left of the midclavicular line. With valvular stenosis a thrill is sometimes felt

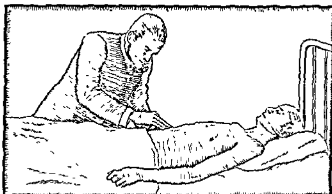
The size and shape of the heart are determined by percussion. Although this method of measurement is not too accurate, it gives a general idea of the size of the heart.

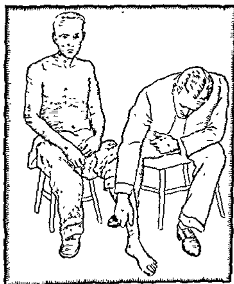
Auscultation over the precordium is performed with the stethoscope. Each valve area is examined with special attention given to the individual heart sounds, noting the type, time, and the presence of murmurs.

Blood pressure is determined with a sphygmomanometer. The normal blood pressure ranges between 90 and 140 systolic and 70 and 90 diastolic A moderate rise in blood pressure

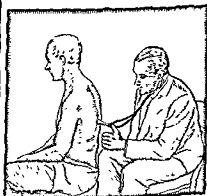
occurs during excitement, exercise, and emotional disturbance. Abnormal high blood pressure occurs in hypertension, renal disease, and thyrotoxicosis. Low blood pressure (hypotension) is seen in patients suffering from chronic diseases such as

A.





B.

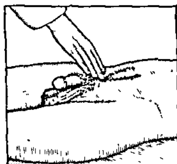


C

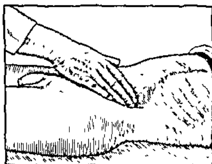
Fig. 37.—Examination for congestive heart failure. *A*, Palpation of liver; *B*, edema of ankles, *C*, auscultation of bases of the lungs. (*From* Clendening and Hashinger Methods of Diagnosis.)

tuberculosis and hypothyroidism and in acute illnesses such as cardiac failure, myocardial infarction, and peripheral circulatory collapse.

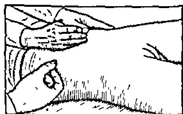
After completing the examination of the lungs and heart with the patient in the sitting position, they are re-examined in the recumbent position.



Deep palpation of Right Iliac Fossa



Deep palpation of Left Hypochondrium



Elicitation of Fluid Wave in Suspected Ascites



Deep palpation using both hands; this distributes pressure very evenly.

Fig. 38.—Palpation of the abdomen. (From Clendening and Hashinger· Methods of Diagnosis)

Examinations of the Abdomen.—The abdomen is inspected for distention, retraction, symmetry, local prominences, and peristaltic waves. On palpation the examiner notes localized tenderness, muscular spasm, the presence of abnormal enlargement of the liver, spleen, and kidneys, and tumor masses. The size of the liver and spleen are determined by percussion as well

as by palpation. A dull percussion note in the flanks indicates fluid. The inguinal rings and umbilical region are examined for hernias.

Examination of the Spine.—The spine is examined for tenderness, lack of mobility, kyphosis, scoliosis, and lordosis.

Examination of the Extremities.—The arms, hands, legs, and feet are examined for abnormal development, bony prominences, clubbing of the fingers and toes, cyanosis, and fractures. They are tested for reflexes and sensation. Special attention is given to the joints, their shape and function.

Examination of the Genitalia.—These are inspected for development and malformation and hair distribution. Their development is considered in relation to the patient's age; they may be infantile, mature, or senile. In males the scrotum is examined for the presence of testicles and tumors. In females the vagina is inspected for tumors and cervical erosions. By vaginal palpation the size and shape of the uterus may be determined.

By the rectal examination the doctor notes the size of the prostate in males, and feels for tumor growths in both males and females.

After the history and physical examination have been completed, the doctor summarizes his findings and makes a tentative diagnosis. If necessary, he orders the laboratory and diagnostic procedures he thinks are indicated. When all data finally have been accummulated, he discusses the condition with the patient and gives the necessary advice and treatment.

SAMPLE CASE HISTORY AND PHYSICAL EXAMINATION

History Case 40, white female, age 25, school teacher, date, 5-16-48

Chief Complaints:

1. Nervousness	*4 months*
2. Trembling of hands and feet	4 months
3. Pounding of heart	*4 months*
4. Increase in appetite	*3 months*
5. Loss of weight (15 pounds)	*3 months*

Present Illness

Patient states she felt well until
she noticed a gradual onset of nerv
her students, her hands trembled,
upset by her students, she felt her h

a hammer striking a board. Becoming irritated with her eighth-grade pupils was most unusual, because prior to this time she had always been patient and understanding. She talked to the school principal about her increased irritability and he advised a few days' rest. She refused to leave because of the teacher shortage. On 2-6-48 she noted for the first time that her clothes were loose. This seemed strange since her appetite had been good, if not much better than usual. She discovered that she had lost 15 pounds in weight—from 120 to 105 pounds. These symptoms have become progressively worse, particularly during the last two weeks.

The patient is mentally alert and cooperative and gives a well-organized, detailed description of her symptoms.

Family History:

ortance.
ent was particularly
eeks after her
vas almost im-
noon nap and
. Patient states
that since the shock of her mother's death she has felt "high strung" and nervous inside.

Past History:

As a child patient was plump, short, and stocky but always in good health. Had measles and chicken pox at the age of 5 years without secondary complications.

Review of the systems reveals no abnormalities

Social History:

Attended grade school and high school and made average grades. Association with schoolmates and friends was good She has felt generally satisfied with her life and environment. She dates occasionally but has formed no steady attachment.

Habits.

Smokes and drinks intoxicating beverages occasionally Dietary habits are good Sleeps well, 6 to 8 hours a night.

Physical Examination

Height, 5 ft., 3 in., weight, 102 pounds; temperature, 99 0°, pulse, 120; respirations, 15, blood pressure, 140/80.

Patient is a well-developed, well-nourished, 25-year-old white female. She is alert and cooperative but is very nervous—changes her position frequently and constantly rubs the palms of her hands together.

Head: Normal.

Ears, Nose, Throat Normal.

Eyes Moderate protrusion of eyeballs with wide palpebral slits. Lid lag present Pupils react to light and accommodation. Fundi normal.

Neck No venous distention or arterial pulsations Lymph nodes not palpable. Thyroid gland is palpable with generalized, diffuse enlargement, but not marked

Lungs: Thorax is symmetrical. Lungs clear to percussion, auscultation, and palpation.

Heart: Blood pressure, 140/80; pulse, 120; apex beat felt in fifth interspace in left midclavicular line. Sounds are of good quality but accentuated and forceful. The first heart sound accentuated more than normal. No murmurs heard.

Abdomen: Flat and symmetrical. No masses or tenderness present. Liver, spleen, and kidneys not palpable.

Extremities: No abnormalities. Skin on palms of hands moist. With arms extended at full length, there is a fine tremor of the fingers.

Skin: Warm and moist.

Reflexes: All tendon reflexes are hyperactive but are within normal limits.

Rectal and Vaginal Normal. History is obtained from patient and is reliable.

Diagnosis:

Hyperthyroidism, moderate, with minimal exophthalmos.

Tests done to complete the diagnosis		*Results*
Orders:	1. Complete blood count	Normal
	2. Basal metabolism rate	+30
	3. Blood cholesterol	130
	4. Urinalysis	Normal

Hyperthyroidism is suggested by the history and physical examination. Laboratory data are used to confirm the diagnosis.

The most important test is the basal metabolic rate. It is necessary to repeat this test several times to avoid errors. Normal basal metabolic rates range from +10 to —10. Thyrotoxic patients will have a rate above +10.

Other tests that are helpful are the blood cholesterol and blood count. Patients with hyperthyroidism usually have a low blood cholesterol This test is not too reliable, since some patients with hyperthyroidism have a normal blood cholesterol. The characteristic blood picture of hyperthyroidism is an increased total white blood count with an increase in the lymphocytes and monocytes. (Relative lymphocytosis and monocytosis.)

In some cases it is necessary to make use of a therapeutic test with iodine or a biopsy of the thyroid gland.

Present-day therapy consists of methods which suppress the excessive production of the hormone thyroxin that produces the hyperthyroid state. These are iodine, thiouracil, propylthiouracil, surgical removal of the gland, x-ray treatment, and radioactive iodine.

CHAPTER 17

LABORATORY DIAGNOSIS

Introduction.—The nurse must be familiar with the numerous diagnostic laboratory tests which are in common use in clinical medicine. Often the responsibility for collecting and handling the various specimens such as urine, sputum, etc., rests with the nurse, after which it may be her duty to see that they are sent to the laboratory with the necessary precautions.

All specimens must be handled with scrupulous attention to instructions or they may be worthless for examination; they may even give misleading results. Some tests require that specimens be collected over a period of several hours. This may be tiring to the patient, and it is therefore of utmost importance that the nurse watch and ensure his cooperation. The containers used for collecting the specimens must be kept clean, sterile if necessary. When collecting a specimen the nurse must be cautious not to spill the material or contaminate the outside of the containers, for this may be dangerous to the health of those who handle them. The contents must not come in contact with the stopper, therefore the containers must not be tipped sidewise or turned upside down.

The nurse should explain to the patient the procedure used in collecting a specimen, thereby obtaining his intelligent cooperation.

Before sending a specimen to the laboratory, the nurse fills out a requisition slip which includes the date, hour, ward, the doctor's and patient's name, the age of the patient, type of specimen, and type of examination desired. (See example.) She also makes a notation on the patient's chart when the specimen was obtained and sent to the laboratory. If an emergency examination is requested, she marks the requisition as such and notifies the laboratory. After the test has been

	Date________________
HOSPITAL	Hosp. No ______________
Laboratory Request	Ward________________
	Interne______________

Name (Print)______________ ______________ Sex_____ Age___
(Last Name) (First Name)

Material____________________________________

Test Desired________________________________

Clinical Diagnosis____________________________

Remarks____________________________________

____

____

Results_____________________________________

completed, the laboratory will return a written report to the ward. This is placed in the patient's record and becomes a permanent part thereof. It should be removed only under exceptional circumstances, and in such cases a receipt should be left in the record by the person responsible for its removal.

URINE

Routine Examination.—Examination of the urine is one of the routine laboratory tests. The information thus obtained may indicate disease elsewhere in the body, such as diabetes or liver disease. Urine normally contains many of the substances present in the blood except protein and blood cells A routine examination of urine includes measurements of the volume, specific gravity, odor, turbidity, color, and reaction; chemical tests for albumin (protein) and sugar. The presence of either *albumin or sugar indicates pathology* and a quantitative estimation should be made; when sugar is present in the urine, chemical tests for acetone bodies and dia-

cetic acid are done. A microscopic examination is done on the urinary sediment for red and white blood cells and other formed elements. There are numerous special examinations for determining kidney function for the presence of pathological substances.

Patients who come to the doctor's office or the laboratory should void urine there for the examination, but if this is inconvenient, they should collect the specimen at home just before leaving for their appointment. For insurance examinations *the specimen must be passed in the presence of the* examiner or the nurse. In the hospital, urine specimens are collected by the nurse. Special care must be taken that the patient uses a clean bedpan or urinal to prevent contamination with substances that might influence the tests. After the urine has been collected it is transferred to a urine specimen bottle which is closed with a paper stopper. Vaginal secretions will interfere with the examination. Women should be instructed to cleanse the vulva thoroughly with soap and water before voiding. Catheterized specimens from females are preferable since they are free of bacteria and cellular elements from the vulva and vagina.

For a routine examination the urine should be a freshly or recently voided specimen, but for a quantitative analysis the urine *voided during a twenty-four-hour period is collected.* All specimens of urine should be sent to the laboratory immediately. If there is a delay, contaminating bacteria will, in a few hours, multiply and alter the formed elements, such as blood and casts, that may be present. Bacteria will also change the reaction of the urine to alkaline, and it becomes cloudy due to precipitation of salts Old specimens should not be examined if it can be avoided. However, if a delay is inevitable in getting the specimen to the laboratory, a preservative such as thymol, formalin, chloroform, or toluol may be added. Preservatives will not keep specimens in perfect condition. Formalin and chloroform will give false positive reactions for sugar. At all times urine specimens should be kept in a cool place or in a refrigerator This prevents bacterial growth.

When collecting a specimen for the quantitative analysis test, all the urine voided during a twenty-four hour period is saved and placed in a large container with two or three

crystals of thymol. The specimen is used to determine quantity of albumin, chloride, or nitrogen present. If the urine is collected for a quantitative sugar analysis, a preservative is not added. Since bacteria reduce sugar, the urine must be kept in the refrigerator.

To collect a twenty-four hour specimen, the patient empties the bladder at the beginning of the period (8:00 A.M.). This specimen is discarded. All urine voided in twenty-four hours, including the last one, is collected. The nurse mixes the specimens, measures the total volume in cubic centimeters, records it on the patient's chart and requisition slip, and sends it to the laboratory.

The collection and handling of specimens in the various special kidney function tests will be discussed on p. 228.

General Characteristics of Urine.—

Volume: Normally, during a twenty-four hour period an individual will pass from 1,200 to 1,500 cc of urine. The volume passed depends upon the amount of water and other liquids consumed. The output is increased if the fluid intake is unrestricted or decreased if fluids are restricted or excessive sweating or dehydration have occurred.

The volume is increased 3 to 10 liters (polyuria), especially in diabetes mellitus, diabetes insipidus, and chronic nephritis. In patients with edema due to kidney disease or heart failure, polyuria may occur spontaneously or after the administration of mercurial or xanthine diuretics. Sometimes a moderate polyuria will occur during convalescence from a high fever.

In some conditions the urinary secretion is markedly diminished (oliguria) or suppressed (anuria). (See Chapter 13.)

Normally more urine is passed during the day than during the night. If the quantity of urine is increased at night (nocturnal polyuria), it indicates a functional disorder of the kidneys or a compensatory kidney reaction due to the inability to excrete sufficiently during the daytime.

Specific Gravity: This test determines the weight or density of the urine as compared with that of distilled water. The specific gravity of water is 1 000; that of normal urine ranges between 1.008 to 1.025. The difference is due to solid substances in the urine. The first voided urine in the morning is the most concentrated and may have a specific gravity of 1 025 if the

intake of fluid has been restricted since the evening meal.' If there has been an increase in ingestion of water, low salt intake, or a restricted diet, the specific gravity will be low; if body water is lost by vomiting, diarrhea, or sweating, the specific gravity will be higher.

Normal kidneys should be able to dilute the urine to a specific gravity of 1.003 following the intake of 1,500 cc of water on an empty stomach or concentrate the urine to at least 1.025 if fluids have been restricted for twenty-four hours. Failure of the kidneys to dilute or concentrate urine within these limits indicates renal damage.

In diabetes mellitus the output of urine is increased but the specific gravity is high, 1.030 to 1.050, because of the sugar in solution. In nephritis the damaged kidneys are at first unable to secrete a urine of high specific gravity; they also fail to dilute and later in the disease the specific gravity becomes somewhat fixed at about 1 010. This is due to the inability of the injured renal tubules to concentrate or reabsorb water. In diabetes insipidus (pituitary deficiency) the volume of urine is abnormally large and the specific gravity is low, 1.010, or lower, simply from the dilution of the normal urinary contents.

The specific gravity is determined by means of the urinometer. This is a calibrated glass float with a weighted glass bulb at the bottom. A glass cylinder is filled with urine (50 to 70 cc) and the float is put in the urine. The float must not touch the sides of the cylinder. The eye of the observer should be held level with the meniscus which the urine makes against the float. The specific gravity is read as 1.020, or whatever number is level with the meniscus.

Odor: Normal urine usually has a faint aromatic odor. If urine is allowed to stand for any length of time it undergoes decomposition due to the multiplication of bacteria which by their action produce ammonia. The urine may have a putrid odor if there is extensive infection of the urinary tract, such as cystitis, or kidney abscess.

Color: The color of normal urine will vary, depending upon the quantity of fluid ingested. Normal urine is yellow due to the pigment urochrome. After drinking large amounts of liquids the urine is diluted, and it becomes very pale or light yellow. People who drink very little water will void small amounts of concentrated dark yellow urine. This latter condi-

tion is very common during warm weather when there is excessive sweating, even if the intake of fluid is increased. With prolonged vomiting and diarrhea the urine becomes concentrated and dark. With high fevers the urine may have a reddish tinge due to the pigment uro-erythin. In diabetes mellitus and diabetes insipidus, in which the output of urine is increased 3 to 10 or more liters, the urine is dilute and pale. In chronic nephritis the kidneys lose their power to concentrate due to tubular damage, and the urine produced is pale.

In certain diseases the color of urine changes due to the presence of abnormal pigments in the urine. Urine containing bile is greenish-brown or orange-yellow in color, and shaking will produce a yellow foam. The patient may note a change in color of the urine before jaundice develops. Urine containing the pigment melanin due to malignant melanoma becomes black upon standing. A congenital anomaly, alkaptonuria, produces a substance (homogentisic acid) which also turns the urine black on standing. Blood in the urine (hematuria) gives a red-brown or smoky color. Hemoglobin in the urine (hemoglobinuria) unaccompanied by red blood cells, as occurs in hemolytic anemia and jaundice, gives a dark yellow color

Some drugs may cause an abnormal color in the urine. Senna and cascara give a brown color that changes to red if the urine is alkaline; methylene blue gives a greenish-blue color; phenol gives a brown-black color; pyridium gives an orange color. Argyrol used as medical instillation into the bladder gives a slate-gray color to the urine.

Certain foods such as asparagus and rhubarb contain pigments that give urine a brown-yellow color

Transparency and Turbidity: Freshly passed urine is normally clear, but it may be cloudy when alkaline due to the presence of carbonates and phosphates Upon standing, a faint clouding may appear from the settling out of mucus, epithelial cells, and bacterial decomposition. If the urine is acid, a white or pinkish sediment of urates may appear. In alkaline urine a phosphate sediment will form. Pus and blood in the urine cause turbidity, the former being white and the latter red and smoky. A milky urine (chyluria) is usually due to the presence of chyle. This occurs, for instance, in filariasis which may obstruct the lymph vessels of the urinary tract, causing them to rupture.

Reaction: This is a test performed to determine whether the urine is acid or alkaline. The urine is tested with litmus or nitrazine paper. A strip of litmus is dipped into the urine specimen; if acid, the blue litmus paper turns red; if alkaline, the red litmus paper turns blue. If the paper does not change color, the urine is neutral. Nitrazine paper is a more sensitive indicator than litmus paper and is used to determine the hydrogen ion concentration (pH) of the urine as well as other body fluids. A strip of paper is moistened with a drop of urine, and after waiting one or two minutes, the nitrazine paper changes color (bright yellow, pH 4.0, green, pH 6.0, to gray, pH 6.6, to blue, pH 7.6), depending upon the pH of the urine. A complete color value chart comes with each tube of nitrazine paper so only a few are given here. A pH of 7.0 is neutral; above 7.0, alkaline; below 7.0, acid. In general, the litmus paper method is satisfactory. The nitrazine paper method is used when the exact pH value is desired and necessary for treatment of acidosis and urinary infections. Some urinary drugs such as mandelic acid are effective only when the urine is at a certain pH, while sulfonamides are more effective in an alkaline urine.

In most instances the normal voided twenty-four-hour urine is acid. However, this may be influenced by the type of diet or drugs used. Fruits and vegetables render the urine alkaline, a high protein diet (meats) or fasting produces an acid urine. Drugs such as sodium bicarbonate and potassium acetate make the urine alkaline, phosphoric and mandelic acid result in an acid urine.

Infections of the urinary tract such as cystitis and pyelitis produce an alkaline urine because the bacteria split urea into ammonia. Urine left standing in a warm room becomes alkaline because of the formation of ammonia by the contaminating bacteria.

Albumin: Albumin in the urine (albuminuria) comes from the blood plasma and may indicate inflammation of the small capillaries that are located in the kidney cortex. When injured by disease, the permeability of the vessel wall increases, allowing the protein to leave the blood and pass into the kidney tubules.

Albuminuria is usually considered pathological and evidence of kidney disease, but it may occur in such benign disorders

as low blood pressure, lordosis, pressure on the renal veins during pregnancy, and orthostatic albuminuria. These conditions are common and unimportant. They probably constitute (numerically) the greatest number of cases of albuminuria. This latter condition is due to a minor disturbance in renal physiology rather than to a structural change in the kidneys. The patients are usually young, thin, and poorly developed physically. The albumin appears in the urine on standing or sitting and disappears when the patient lies down

In acute febrile diseases such as scarlet fever, measles, and pneumonia, a slight albuminuria may occur. This is usually temporary and gradually disappears with convalescence, but it may remain longer. Impairment of kidney circulation as occurs in chronic heart disease, anemia, and violent exercise may cause a mild albuminuria. Various drugs such as mercury, arsenic, and lead may cause renal irritation and albuminuria If these irritants continue to be present, they may eventually produce permanent kidney damage and lead to nephritis.

Infections of the renal pelvis (pyelitis), ureters, bladder, and urethra cause albuminuria. This is due to the presence of pus (bacteria, white and red blood cells) in the urine. In menstruating women and in those with a vaginal discharge the urine may show albumin for the same reason. In renal tuberculosis and amyloidosis albuminuria is not a constant finding.

The chief concern in finding albumin in the urine is that it may be a sign of nephritis. In degenerative nephritis (nephrosis) the quantity of albumin excreted by the kidneys is usually very large. In the acute and chronic stages of hemorrhagic nephritis there is a marked albuminuria. As the disease progresses and the terminal stage is reached, albuminuria decreases Nephritis due to arteriosclerosis produces inconstant traces of albumin Patients with benign essential hypertension may show only an occasional trace of albumin, while those with malignant hypertension may have a marked albuminuria. Patients in heart failure usually show a faint trace of albumin in the urine.

There are many tests used to determine the presence of albumin: heat and acetic acid, Heller's nitric acid test, and Roberts' test. The heat and acetic acid test is the test commonly used. If the urine is cloudy, it must be filtered or centrifuged before being tested for albumin.

To perform the heat and acetic acid test, a test tube is filled three-fourths full of clear urine. The tube is held at the bottom and the upper portion is heated until boiling in the flame of the Bunsen burner. If albumin is present, a cloud will appear in the urine. However, this may be due to phosphates or carbonates Such a cloud will disappear if 3 to 5 drops of glacial acetic acid are added to the urine. If a flocculent cloud appears when the acidified urine is heated to 60° C. and disappears when the urine is brought to boiling, Bence Jones protein is present. This substance occurs in multiple myeloma, leukemia, empyema, and bone tumors.

Qualitative tests as above are usually reported as follows:

Negative
Trace

1 plus
2 plus
3 plus
4 plus

A positive reaction may be caused by mucin which comes from the secreting glands and mucous membranes of the urinary passage. It is of no clinical significance. It is differentiated from albumin by adding acetic acid to cold urine; mucin then produces a faint cloud

The quantitative tests are used to determine the amount of albumin lost from the body over a twenty-four hour period. There are several methods: Esbach's, Tuschiya's, Exton's, and Purdy's. None of these methods is absolutely accurate. The most common and simple method used is Esbach's. A sample of clear acid urine is mixed with Esbach's reagent and placed in a specially calibrated Esbach's tube. At the end of twenty-four hours the height of the precipitate in the tube is read in grams of albumin per liter of urine.

Sugar: The glucose which is present in the blood is normally excreted in the urine, but it contains such minute traces thereof that they are not recognized by the customary tests. This is because the kidney constitutes a barrier which does not allow glucose to pass unless its concentration exceeds a certain value. This value is called the "threshold value," and it is normally about 160 to 180 mg. per 100 cc but varies somewhat individually. Glycosuria is the presence of glucose in the urine. This may occur when the glucose in the urine exceeds the

normal threshold (hyperglycemia), or when the threshold is lowered, in which case glycosuria may occur in the presence of a normal blood sugar (renal glycosuria). This condition is probably innocent.

Small amounts of glucose may appear in the urine after a *general anesthesia and in pregnancy, hyperthyroidism, shock,* head injuries, chilling, and emotional strain (fear, anger). It is common for glycosuria to occur after the intravenous or subcutaneous injection of glucose or after eating a meal high in sugar content. In these conditions the glycosuria is usually transitory and has little clinical significance. The blood sugar and renal function tests are within normal limits.

The most common causes of a persistent glycosuria is diabetes mellitus. However, very mild diabetes may exist without glycosuria. Diabetes is caused by a lowered production of insulin by the pancreas. The body sugar cannot be utilized or stored so a high level of blood sugar is the result. A rare disease, hemochromatosis, may also produce glycosuria.

Other diseases that produce glycosuria are pituitary disorders (acromegaly), cerebral hemorrhage, and nephritis.

Besides glucose, other sugars such as lactose and pentose may appear in the urine Lactose in the urine is usually associated with pregnancy and lactation It can be differentiated from glucose by the fermentation test. It does *not* ferment.

There are numerous methods used to detect sugar in the urine: Benedict's test, Fehling's test, phenylhydrazine test, and the fermentation test. The Benedict's test is the method most frequently used

To test for sugar, pı
8 to 10 drops of urine
red, yellow, or green
of glucose which is present.

Clear blue solution	Negative (no sugar present)
1 plus	A faint green-blue cloudy solution
2 plus	Green-yellow precipitate
3 plus	Yellow-orange precipitate
4 plus	Orange to red precipitate

Albumin in more than a moderate concentration may interfere with the test. This is prevented by acidifying the urine with acetic acid, boiling, and filtering In normal urine a bluish precipitate due to urates may appear on standing.

The quantitative estimation of sugar is used to determine the amount of sugar excreted over a twenty-four hour period. It is very important in giving the proper treatment to the diabetic patient. Since preservatives and bacteria will alter the test, the urine must be kept in the refrigerator at all times.

In untreated diabetes, acetone bodies (acetone, diacetic acid, and hydroxybutyric acid) may appear in the urine. They are signs of impending danger. If allowed to accumulate in the body they will produce acidosis, later coma, and finally death. *If these acids are found in the blood or urine, ketosis is said to exist.* They are the incomplete end products of fat metabolism. Fat metabolism requires carbohydrates for its completion. In severe diabetes, carbohydrates are metabolized in an amount insufficient to support fat metabolism This is a result of the lack of insulin which is necessary for carbohydrate metabolism. Insulin is a secretion from the islets of Langerhans in the pancreas. Ketosis also occurs in starvation where the sugar in the body is depleted and the metabolism of fat increases. High fevers, eclampsia, and pernicious vomiting of pregnancy also produce ketosis.

Every urine containing sugar should be tested for acetone bodies. There are two methods of doing this. (1) by Lang's test and (2) by Rothera's test Rothera's test is the more sensitive.

In this test 1 gram of ammonium sulfate is dissolved in 3 cc of acidified urine. Shake the mixture well, and then add 3 drops of fresh nitroprusside solution. With the test tube tipped at an angle, place several drops of concentrated ammonia on top of the mixture If acetone bodies are present, a red to purple ring will form at the point of contact of the *ammonia with the other liquid.*

If the test for acetone is positive, the urine should be further tested for the presence of diacetic acid by means of Gerhardt's test.

To 3 cc of urine add several drops of 10 per cent ferric chloride 1 drop at a time until no more precipitate is formed. Centrifuge or filter and again add several drops of ferric chloride. If diacetic acid is present, the solution becomes a deep red or purple. Such drugs as phenol, salicylates, and sodium bicarbonate may give a false positive

The urine of children must be checked frequently for acetone bodies, for children will develop acidosis more easily

than will adults. Individuals showing acetone bodies in the urine should not be operated upon except in absolute emergencies for the anesthetic will increase acidosis. If an operation is necessary, special measures are indicated to cope with the acidosis.

Microscopic Examination: *For a urinalysis examination to be complete a microscopic study is essential.* Just because urine appears clear to the naked eye one cannot exclude the presence of structures (white blood cells, leucocytes; red blood cells, erythrocytes, etc.) that are of diagnostic importance. Clear urine may reveal pathology, while a cloudy urine may contain no pathological structures. The freshly voided specimen must be examined immediately or within four to six hours; otherwise the sediment might change due to the breaking up of the red blood cells, casts, and the multiplication of bacteria. If there is to be a delay in making the microscopic examination, a preservative should be added—4 to 6 drops of formalin or 1 cc of toluene.

To prepare the specimen for examination, 10 to 20 cc of urine should be centrifuged at 1,500 to 2,000 revolutions per minute for one to two minutes. This concentrates the suspended particles. The particles are thrown to the bottom of the tube, leaving a clear supernatant fluid which is gently agitated to break up the sediment, of which a few drops are placed on a glass slide that is covered with a thin cover glass. It is then examined with the microscope under high and low power. Proper illumination is essential for the identification of the different cells, casts, etc. If there is difficulty in distinguishing between red and white blood cells, a drop of 25 per cent acetic acid placed under the cover slip will bring out the nuclei of the white blood cells. Occasionally, it is necessary to study structures in detail. In such cases, a small wire loopful of sediment is placed on a glass slide, and it is stained with Gram's, acid-fast, Wright's, or methylene blue stain.

The sediment obtained from normal urine may be minute or very heavy, depending upon the patient's diet and fluid intake and concentration and reaction of the urine. The substances usually found are epithelial cells from the mucous membrane of the urinary tract, a variety of crystals, occasional white cells, casts, and rarely red blood cells. Unless

the specimen from women is obtained by catheterization, the sediment is usually very heavy due to secretions from the vulva and vagina.

Crystals: Crystals are the most common particles found in the sediment. They are of little clinical significance. A very heavy sediment of crystals usually means that the urine has stood for a long time.

The crystals that may be found in acid urine are uric acid, sodium urate, amorphous urates, calcium oxalate, cystine, leucine, tyrosine, and fat globules. The first four of the group are commonly found in acid urine, while the latter group are rare. The presence of leucine or tyrosine crystals indicates a breakdown of tissue protein or destruction of the liver. Cystine crystals are thought to be connected with the formation of renal stones. During the administration of sulfonamide drugs their crystals may appear in the urine. Fat globules in the urine usually come from contaminated oily catheters or specimen bottles.

In alkaline urines the crystals found are the triple phosphates, calcium phosphate, amorphous phosphate, magnesium phosphate, calcium carbonate, and ammonium urate. These crystals rarely have any clinical significance.

Of greater importance than the crystals and indicative of disease is the presence of red blood cells, white blood cells (pus), epithelial cells, bacteria, parasites, and casts.

Red Blood Cells: Occasional red blood cells are found in normal urine, but any considerable number is pathological. In women blood may reach the urine from the rectum or the genital tract, and these sources must be excluded. In men all blood in the urine comes from the genitourinary tract.

Hematuria (bloody urine) may occur from a large variety of diseases. The amount of bleeding is not necessarily an indication of the size or nature of the pathological lesion. The most common causes of hematuria are kidney or bladder *tumors, polycystic kidney, renal or ureteral stones, nephritis,* pyelonephritis, renal infarction and tuberculosis. In general, gross hematuria is associated with tumors, polycystic kidney, and the acute stage of nephritis; colicky pain and hematuria are associated with renal stones; sudden low back pain accompanied by high temperature is usually associated

with kidney infarction. Mild hematuria with casts and epithelial cells may be found in heart failure due to congestion of the kidneys; hematuria with pus cells is found in renal tuberculosis, pyelonephritis, and cystitis. Gross hematuria may occur after severe contusion or injury to the abdomen or lumbar region and indicates damage to the urinary tract.

The red blood cells should be counted and reported as the number found per high-power field. If a more accurate determination is desired, the Addis count method is used. Here, the sediment is placed on a blood counting chamber (hemacytometer); the number of red blood cells are counted and the total number computed. Casts and white blood cells can also be counted by this same method.

Blood may be present in the urine not as red blood cells but as hemoglobin from broken up red cells (hemoglobinuria). This is detected by chemical tests. Hemoglobinuria may appear after severe burns and mismatched blood transfusions and in malaria and mushroom, potassium chlorate, and carbon monoxide poisoning. A rare type of hemoglobinuria (paroxysmal hemoglobinuria) may appear after exposure to cold which, in certain persons, produces hemolysis of the red blood cells.

White Blood Cells (Pus Cells): Normal catheterized urine contains two or three leucocytes per high-power field; more than this is considered pathological. The majority of leucocytes will be neutrophiles, and they will appear singly or in clumps. They are reported in the same manner as are red blood cells, along with the number of clumps observed.

Pus cells in the urine (pyuria) indicate inflammation of the urinary tract such as pyelitis, cystitis, pyelonephritis, pyelonephrosis, tuberculosis of the kidney, and urethritis There is no definite way to tell from which part in the urinary tract the pus cells arise. Occasionally the "two-glass method" is used in males to differentiate urethritis from lesions higher in the tract. The patient voids into two glasses. If pus cells are found in the first glass but not in the second, the leucocytes are said to come from a lesion in the urethra. If the pus cells appear in casts or are attached to casts, they come from lesions in the kidneys. Pus cells associated with red blood cells and epithelial cells occur in nephritis

If more detailed study is required and it is necessary to determine whether one or both kidneys are infected, catheter-

ization of the ureters is done. In this manner urine may be obtained separately from each kidney.

Epithelial Cells: Normal urine contains desquamated cells from the mucous membranes of the urethra, bladder, and vagina. If present in abnormally large numbers, they may indicate inflammation of the urinary tract. In nephritis and kidney congestion due to heart failure, large, round, granular cells due to desquamation of the convoluted renal tubules appear.



Fig 39 Urinary casts in chronic nephritis Highpower field showing (*1*) waxy casts, (*2*) epithelial cell cast, (*3*) finely granular cast, (*4*) renal failure cast of Addis, (*5*) renal epithelial cell, showing fatty degeneration (From Bray Clinical Laboratory Methods, The C. V Mosby Co.)

Casts: A urinary cast is a mold of the renal tubules consisting of clotted blood, epithelial cells or albuminous matter, or any substance excreted by the kidneys The casts are recognized by their composition Hyaline casts are colorless cylindrical structures and have little significance. They appear

after general anesthetics, in high fevers, after exertion, and in congestion of the kidneys. Waxy casts are clear like the hyaline casts but are wider and shorter with rough ends. They appear in the late stages of nephritis and amyloid disease of the kidneys. Coarse or fine granular casts represent broken down epithelial cells and are the same as hyaline casts except that they contain numerous granules. They indicate inflammation of the kidneys. Other casts to appear in the urine which indicate inflammation or irritation of the kidney are epithelial casts, red blood cell casts, pus cell casts, fatty casts, mucous casts, and cylindroids.

Parasites: Parasitic infestation of the urinary tract is uncommon. In women, *Trichomonas vaginalis* is a frequent cause of vaginitis; these organisms may reach the bladder by way of the urethra and produce irritation or a mild cystitis In men, *Trichomonas hominis* may produce bladder irritation. In Africa the blood fluke *Schistosoma haematobium* lives in the small veins of the bladder where it produces its eggs, and these are observed in the urine usually associated with pus and blood.

Artifacts: Sometimes outside substances such as yeast cells, oil droplets, starch granules, fiber strands, and pollen granules get into the urine through accidental contamination. It is important that these extraneous substances be recognized lest they be confused with pathological structures.

Renal Function Tests.—The main functions of the kidneys are to excrete the waste products of protein metabolism and of other body processes and the poisonous substances introduced into the body from the outside; and to regulate the output of water by concentration or dilution of the urine. When the kidneys become diseased, these functions are impaired and the organs are unable to maintain the equilibrium of the substances in the blood necessary for health. All the renal tests are too numerous to mention here so only a few more important ones will be discussed.

Phenolsulfonphthalein Test (PSP): This is a simple, safe test based on the ability of the kidneys to concentrate and excrete a dye within a limited time (two hours). At the beginning of the test the patient voids so as to empty his

bladder completely. If urinary retention exists, he should be catheterized and the catheter left in the bladder for the entire time of the test to collect the urine specimens. One cubic centimeter (6 mg.) of the dye may be injected intramuscularly or intravenously. If the intramuscular method is used, a full ten minutes must elapse to allow for complete absorption of the dye from the muscle.

(a) Intramusc
water. Fifteen
specimen is di
deltoid muscle.
patient empty the bladder. This specimen is retained in a separate container that is properly labeled. At the end of 2 hours and 10 minutes collect a second specimen.

(b) Intravenous method: After the dye has been injected into the vein, the patient drinks 1 glass of water (200 cc). One hour after the
is collected. The patient drinks
). At the end of the second hour

the patient empty the bladder and
cc of the dye intravenously. Urine
inutes for 1 hour, and then one
he second hour.

It is important for the nurse to remember that all the specimens, regardless of the method used, must be collected and retained in separate containers with the time of collection clearly marked on the tag. The specimens are sent to the laboratory where the technician adds 2 cc of 10 per cent sodium hydroxide and dilutes them with water to the total of 1,000 cc and then compares the solution with standard mixtures which contain a known quantity of dye

With the intramuscular method, 40 to 60 per cent of the dye is normally excreted in one hour, and by the end of the second hour 60 to 80 per cent has been excreted. With the intravenous method, 35 to 50 per cent of the dye is excreted during the first fifteen minutes, and after two hours 60 to 75 per cent will be eliminated. If the kidneys are diseased and renal function is impaired, the amount of dye excreted during the first hour is decreased, and none may appear in the second hour.

Concentration Diuresis Tests: This test is used to determine the ability of the kidneys to concentrate urine. Several similar methods have been devised, but the principle of them all is the same. Tests of this type may be used to determine separately the concentrating and diluting power of the kidneys.

After the patient has finished the evening meal, about 6 P.M., all fluids and food are avoided. At the end of 12 hours (6 A.M.), the first urine specimen is collected. All foods and liquids are avoided for another 3 hours, and a second specimen is collected at 9 A.M. Then the patient drinks 1 liter (1,000 cc) of water, at 10 A.M. another 500 cc of water, and at 10:30 A.M. a last 500 cc of water. The urine voided between 9 A.M. and 12 noon is collected for the dilution specimen.

Normal kidneys should be able to concentrate the urine enough to give a specific gravity of 1.028 to 1.030 and excrete at least 900 to 1,100 cc of dilute urine with one of the specimens showing a specific gravity of 1.005 or less.

Urea Clearance Test: Most doctors consider this test the standard renal function test. However, it is not as sensitive as the concentration test but it is more sensitive than the PSP test.

In this test the patient fasts f
ever, 1 or 2 glasses of water
emptied and the specimen is
patient drinks 100 cc of water.
men is collected, and at the sa
urea determination At 9 A.M a
is absolutely necessary that th
and recorded as such. From the
mens, it is possible to calculate
are cleared of urea by the kidneys per minute.

Normal kidneys are able to remove the urea from 75 cc of blood per minute provided the urine volume output is 2 cc per minute; if less than 2 cc of urine output per minute, the kidneys remove the urea from 54 cc of blood per minute.

Inulin and Diodrast Clearance: These two substances are used to differentiate between the function of the glomeruli and tubules. Diodrast is an iodine compound which is excreted by the glomeruli and tubules, while inulin is excreted only by the glomeruli and is not absorbed by the tubules. The amount of inulin removed from the blood is proportional to the rate of glomerular filtration, while the amount of Diodrast excreted is proportional to the volume of blood passing through the kidneys per minute These two methods are used largely in research and in very exacting clinical work.

Miscellaneous Chemical Tests of Urine: At times it is necessary to examine the urine for substances that may not be detected by the routine tests. These include body products that may be produced in excessive amounts during disease, such as bile pigments and amylase. Or, it may be desirable to

demonstrate the inability of the kidneys to excrete such substances as chlorides, or nitrogenous products, or poisons such as mercury, arsenic, etc., that have been introduced from the outside.

Bile: Bile usually appears in the urine in the form of bile pigments such as bilirubin, biliverdin, bile acids, urobilin, and urobilinogen. The most common diseases causing bile to appear in the urine are obstruction of the flow of bile from the liver (tumor and hepatitis), obstruction of the common bile duct by gallstones, and excessive hemolysis of red blood cells (hemolytic jaundice). These conditions produce an abnormal amount of bile in the body. When their concentration surpasses the renal threshold, they appear in the urine. In early biliary obstruction bile may appear in the urine before there is any visible jaundice. The three most common tests used for determining the presence of bile pigments are the foam test, Gmelin's test, and the iodine test

(a) Foam test Fill a test tube half full with urine and shake it vigorously. If bile is present, a yellow-green foam will appear on top of the urine. If bile is not present, the foam will remain white.

(b) Gmelin's test Pour 3 cc of urine into a test tube and add 1 cc of concentrated nitric acid so as to form two layers of liquid At the junction of the two solutions a play of colors (green, red, blue, yellow) will be seen if bile is present The same test may be performed by filtering 100 cc of urine through a piece of filter paper, allowing it to dry partially, and then adding 1 or 2 drops of nitric acid. The same play of colors will be seen if bile is present.

(c) Iodine test The urine is overlaid with a 0 1 per cent alcoholic solution of iodine If bile is present, a green ring will appear at the junction of the two liquids

The bilirubin in the intestinal tract is changed to urobilinogen through the action of the bacteria in the feces. A part of this is converted to urobilin and excreted in the feces; another part is reabsorbed into the portal circulation, passes to the liver, and is reformed into bile. Any urobilinogen that escapes into the general circulation may be excreted in the urine but is changed to urobilin after the urine is voided Increased amounts of urobilin are found in the urine following excessive blood destruction (malaria), in acute infections (scarlet fever, pneumonia), and in diseases associated with liver damage (hepatic cirrhosis, poisons).

Normally, small amounts of urobilinogen are found in the urine When increased, a cherry red color will appear on the

addition of 1 cc of Ehrlich's reagent (Ehrlich's test). Color reactions will appear in normal urine in dilutions up to 1:20.

Amylase or Diastase: Amylase is a digestive enzyme produced by the pancreas. Normal urine contains 10 to 30 units per cubic centimeter. In acute pancreatitis its flow into the intestinal tract is inhibited, and as a result it is absorbed by the blood in excessive amounts and excreted by the kidneys. The output by the kidneys during the first twenty-four to thirty-six hours of an attack of acute pancreatitis may reach 100 to 200 units. In most other pathological conditions the amount of amylase in the urine is normal.

Chloride: The main source of chlorides in the body is from the blood, in the form of sodium chloride (NaCl). Normal kidneys excrete 10 to 15 grams per day (twenty-four hours).

The excretion of chlorides may be decreased in nephritis, pneumonia, and heart failure. This results in the swelling of the tissues (edema), for the retention of chlorides tends to make the tissues hold water. After treatment and during convalescence, chlorides are excreted in excessive amounts.

To test for the presence of chlorides, add 2 to 3 drops of nitric acid to 5 cc of urine to prevent the precipitation of phosphates. Then add 2 to 3 drops of silver nitrate (1 per cent—$AgNO_3$) solution; if a white milky cloud forms, chlorides are present

Nitrogen Products: The relation between the nitrogen ingested in food and that excreted in the urine and feces is called the nitrogen balance. To determine if the nitrogen of the body and the ability of the kidneys to excrete the nitrogenous waste products is normal, the urine is examined by special tests for urea, ammonia, uric acid, creatinine, and total nitrogen. The daily excretion of nitrogen by the average adult is 3 grams per day

Poisons: Poisons such as mercury, arsenic, lead, and barbital are usually taken internally either accidentally or for self-destruction. However, they may be administered for therapeutic reasons, and if taken over a long period of time, poisoning may result. Patients complaining of vague symptoms of long duration or those who are under treatment and develop symptoms should have their urine tested for abnormal amounts of the above-mentioned poisons.

Bacteria: To treat urinary tract infections it is important to know which organism is causing the infection. The organisms most frequently found are *E. coli* from the colon, streptococci, staphylococci, *E. typhosa*, and *N. gonorrhoeae*. A specially stained smear (Ziehl-Neelsen's method) should be made for the tubercle bacillus (tuberculosis). If tuberculosis is suspected, a small amount of urine is injected into a guinea pig, and after six to eight weeks, the animal is killed unless it has died previously, and a post-mortem examination is performed and the tissues examined for tubercular lesions.

All urine specimens should be collected by a sterile catheter, in a sterile container. Precaution must be taken to prevent contamination of the specimen from the outside. The specimen obtained is used for microscopic examination and cultures.

CHAPTER 18

LABORATORY DIAGNOSIS (Continued)

BLOOD

Introduction.—Blood is a fluid (plasma), in which solid elements (blood cells) are suspended. The plasma contains a protein called fibrinogen which is an important factor in the clotting of blood. This occurs after the blood leaves the blood vessels unless special measures have been taken to prevent it. The fibrinogen can be removed from the plasma, and the fluid which then remains is called serum. The formed elements of the blood are the red cells, the white cells, and the platelets. The red cells contain hemoglobin which is the coloring matter of the blood The color of the hemoglobin depends upon the amount of oxygen present; arterial blood is red because it contains a large amount of oxygen, while venous blood is low in oxygen content and is darker and purplish in color. The reaction of blood is alkaline. The volume averages 5 to 6 liters for the adult.

The main functions of the blood are to transport oxygen from the lungs to the tissues and carbon dioxide from the tissues to the lungs; to carry food (glucose, amino acids, and fats) from the digestive tract to the tissues; to remove waste products (urea, uric acid) of tissue metabolism; to maintain a normal water content of the tissues; to carry hormones and certain chemical substances (antitoxins and other *antibodies*) for protection against bacteria and other injurious agents.

The blood cells are formed in the bone marrow and lymphoid tissue. The blood-forming tissues are called the hematopoietic system.

A routine, complete blood count entails a count of the red and the white cells, a determination of the hemoglobin content of the blood, and a "differential" count of the white cells.

The differential count gives the percentage distribution of the various forms of white cells—lymphocytes, neutrophiles, monocytes, etc.

Special blood studies such as a platelet and reticulocyte count, fragility of the red cells, sedimentation rate, and total cell volume (hematocrit) are frequently used to study the various blood dyscrasias and diseases that alter the normal blood picture.

Most of these examinations can be carried out on blood obtained from pricking the finger or the ear lobe in adults and the toe or heel of infants Blood for the cell volume and sedimentation rate is obtained by venepuncture. The skin over the large vein in the bend of the elbow is cleansed with alcohol, and then a sterile needle is inserted into the vein and blood is drawn back into a syringe Then it is put into a bottle or glass test tube containing anticoagulant and gently rotated in a circular motion to prevent coagulation. This blood

NORMAL BLOOD VALUES

(Each item will be discussed fully on subsequent pages)

	AVERAGE	RANGE
Red Cells		
Men	5 0 ml /c mm	4 5 to 6 0
Women	4 5 ml /c mm	4.3 to 5.5
Hemoglobin		
Men	16 Gm./100 cc	13 5 to 18 Gm.
Women	14 Gm /100 cc	12 5 to 16 5 Gm.
Hematocrit		
Men	45% RBC	38 to 54
Women	40% RBC	36 to 47
Mean corpuscular volume	87 cu micra	80 to 94
Mean corpuscular hemoglobin	29 micro-micrograms	27 to 32
Mean corpuscular hemoglobin concentration	35%	33 to 38
Reticulocytes	0.5%	0 5 to 1.0
Sedimentation rate		
Men	4.5 mm.	0.0 to 9
Women	10 0 mm	0 0 to 20
Platelets	300,000 c.mm.	250,000 to 400,000
White cells (Leucocytes)	7,000 c.mm	5,000 to 10,000
Neutrophiles		
Total	60%	40 to 70
Band neutrophiles	3%	0 to 5
Lymphocytes	30%	20 to 40
Monocytes	6%	4 to 8
Eosinophiles	2%	1 to 3
Basophiles	0.5%	0 to 1
Clotting time	3 min.	2 to 4
Bleeding time	2 min	1 to 4

CHAPTER 18

LABORATORY DIAGNOSIS (Continued)

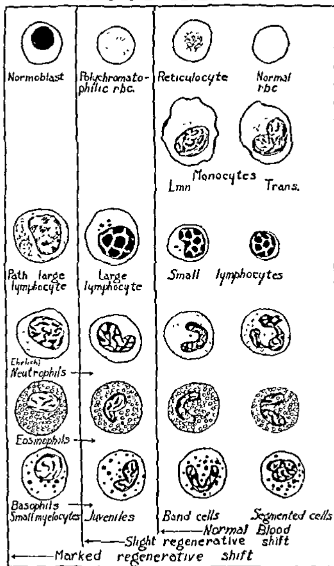
BLOOD

Introduction.—Blood is a fluid (plasma), in which solid elements (blood cells) are suspended. The plasma contains a protein called fibrinogen which is an important factor in the clotting of blood. This occurs after the blood leaves the blood vessels unless special measures have been taken to prevent it. The fibrinogen can be removed from the plasma, and the fluid which then remains is called serum. The formed elements of the blood are the red cells, the white cells, and the platelets. The red cells contain hemoglobin which is the coloring matter of the blood. The color of the hemoglobin depends upon the amount of oxygen present; arterial blood is red because it contains a large amount of oxygen, while venous blood is low in oxygen content and is darker and purplish in color. The reaction of blood is alkaline. The volume averages 5 to 6 liters for the adult.

The main functions of the blood are to transport oxygen from the lungs to the tissues and carbon dioxide from the tissues to the lungs; to carry food (glucose, amino acids, and fats) from the digestive tract to the tissues; to remove waste products (urea, uric acid) of tissue metabolism; to maintain a normal water content of the tissues; to carry hormones and certain chemical substances (antitoxins and other antibodies) for protection against bacteria and other injurious agents.

The blood cells are formed in the bone marrow and lymphoid tissue. The blood-forming tissues are called the hematopoietic system.

A routine, complete blood count entails a count of the red and the white cells, a determination of the hemoglobin content of the blood, and a "differential" count of the white cells.


BLOOD CELLS
Normoblast
Polychromato-philic rbc.
Reticulocyte
Normal rbc
Lmn
Monocytes
Trans.
Path large lymphocyte
Large lymphocyte
Small
lymphocytes
Ehrlich
Neutrophils
Eosinophils
Basophils
Small myelocytes
Juveniles
Band cells
Segmented cells
Normal Blood
Slight regenerative shift
Marked regenerative shift

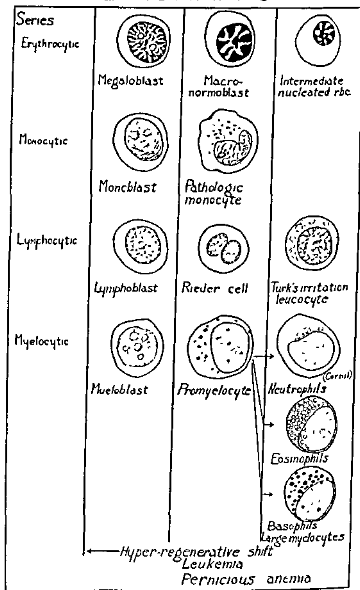


Fig. 40.—Diagram of the blood cells showing their characteristics and relationships. The cells of each series are shown in the order of their maturity from left to right. (From Bray: Clinical Laboratory Methods.)

Red blood cells that become elongated and crescent shaped are found in sickle-cell anemia. They are called "sickle cells."

Method of Counting Red Cells.—

The finger is punctured in the same manner as above. Blood is drawn up into a calibrated red cell pipette to the 0 5 mark and diluted with Hayem's solution up to the 1.01 mark The pipette is gently shaken for 10 minutes to keep the glass bead in constant motion to prevent the cells from settling *The first drop is discarded from the* tip of the pipette, and then the tip of the pipette is placed at the edge of a counting chamber which will fill by capillary traction After allowing the cells to settle for 1 minute, they are counted in the 16 *squares etched on the counting chamber. The common practice is to* count the cells in 5 squares and multiply by 50,000

In routine blood counts a drop of blood is smeared on a glass slide, allowed to dry, and then stained with Wright's stain. This is used for the differential count of the white blood cells and for studying the characteristics of the red cells. The cytoplasm of the red blood cell has an affinity for certain dyes as it is acidophilic and is stained by eosin. If nucleated red blood cells are present, they will be demonstrated by any of the usual stains. A cell with little hemoglobin will appear pale, and the center will be larger than normal. Normal cells take a deeper eosin stain and have a small clear center. The staining of red blood cells by a basic as well as acid dye gives a pale lavender color (polychromatophilia) and is evidence of immature cells In *disease the cells may vary in size (anisocytosis) and shape (poikilocytosis)* These changes in the red blood cells are characteristic of anemia

Reticulocyte counts are done to determine the rate at which red blood cells are regenerating and to follow the response of the bone marrow to therapy used in treating pernicious anemia.

Hemoglobin.—Hemoglobin is a complex protein pigment in the red blood cells It transports the oxygen. It is decomposed *by heat, acids, and alkali The hemoglobin in man differs* from that of animals This difference may have medical-legal significance, when it is important to determine the origin of *blood stains.*

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may be used for any of the above-mentioned examinations However, blood obtained from the finger or ear lobe gives the most accurate blood counts.

It is necessary for the student to be familiar with the normal blood values in order to evaluate changes which occur in disorders which affect the blood.

Red Blood Cells (Erythrocytes)

The red blood cells originate in the bone marrow from large nucleated cells called "mother cells." The youngest cells (megaloblasts) contain a nucleus, and after passing through a maturation phase, they change into erythroblasts, then normoblasts; finally they lose their nucleus but retain a fine reticulum The red cells that contain reticulum are called reticulocytes The fully matured erythrocytes have lost both nucleus and reticulum. After the red cells reach maturity they leave the bone marrow and pass into the peripheral blood. During the stage of maturation the hemoglobin in the red cells is increased in the early forms, but as the cells mature, the hemoglobin content gradually decreases until the fully mature cell is formed, when it becomes stationary

When a drop of fresh blood is placed on a clean, dry, glass slide and examined before it is dry, it is called a "wet preparation"

When a drop of fresh blood is placed on a clean, dry glass slide, then spread into a thin film and allowed to dry, it is called a "dry preparation"

In fresh wet preparations the red blood cells appear as non-mobile, flat, oval, yellow discs with a light center. Some will lie in clumps and others in long rolls like coins in a money roll This is known as "rouleaux formation" and it has no clinical significance If clumping is excessive, the slide has been improperly prepared Some cells will appear as pale transparent discs (ghost cells) due to the loss of hemoglobin.

To make a wet preparation the ball of the patient's finger is cleansed with alcohol, dried with sterile cotton, and punctured with a lancet or needle with one quick stroke The stab should be deep enough to allow a free flow of blood. The first blood to flow is removed with the cotton Pressure should not be applied as it may alter the cells and dilute the blood with tissue serum and lymph. The center of a cover slip is touched to the drop of blood on the finger and placed on top of a glass slide, allowing the blood to spread out in a thin film. The edges of the cover slip should be cemented with petroleum jelly. This type of preparation is best for studying the abnormal shapes of red blood cells, particularly for sickling

that the red cells contain an excess of hemoglobin, while an index below 1.0 indicates that the red cells lack the normal amount of hemoglobin.

Sedimentation Rate.—The sedimentation rate is the speed at which red blood cells will settle to the bottom of a special glass tube 10 cm. long. The rate of fall of the red cells depends upon the amount of fibrinogen, a protein, in the blood and the size of the clumps of red cells that form. The test is useful in detecting the presence of some low-grade infection that might otherwise be overlooked. Its greatest value comes in its use for following the progress of such diseases as rheumatic fever, certain types of arthritis, and tuberculosis and myocardial infarction. The test is not a measure of health or disease as it is too variable and easily affected by normal physiological functions such as excitement, exercise, and eating, *and almost* all *diseases*, whether *acute or chronic*, will give an increased sedimentation rate. In following the progress of disease an elevated sedimentation rate is good evidence that the tissues have not completely healed and that further treatment and bed rest are needed.

The technique used for determining the sedimentation rate is quite easy, but to obtain correct results the blood must be handled with great care; otherwise the figures obtained will be inaccurate Five cubic centimeters of blood are drawn from the antecubital vein and mixed in an oxalated bottle Then 1 0 cc of the blood is placed in a Wintrobe hematocrit tube which is placed in a perpendicular position and observed every 5 to 10 minutes for 1 hour The level to which the red cells have fallen is recorded At the end of the hour, the figures are totaled. The normal sedimentation rate will vary from 0.0 to 6.0 mm. to 10 mm in males and from 0 0 to 12 mm. to 18 mm. in women.

Anemia

Anemia is the quantitative deficiency of red blood cells or of hemoglobin. The degree of anemia depends upon the reduction of red cells and hemoglobin and the evidence of formation of new blood cells Numerous attempts have been made to classify the different anemias, but none has been entirely satisfactory. At present, anemias are classified according to the morphology of the red blood cells, their size, and hemoglobin content. Such a classification is tabulated below. It should be noted that normocytic anemia has the same values as normal blood.

Under normal conditions the hemoglobin is found only i the red blood cells. Hemoglobinemia is the condition in whic hemoglobin is circulating freely in the plasma. It occurs i malaria, severe burns, hemolytic anemia, potassium chlorat poisoning, and some other conditions.

Cell Volume (Hematocrit).—The hematocrit is a measur of the volume of red blood cells per 100 cc of blood.

Blood is drawn from a vein, placed in an oxalated tube and mixed and then transferred to a hematocrit tube which is filled to the 10 cm mark, corked, and centrifuged for 20 minutes at 3,000 r.p.m. This com pletely packs the cells. The result is read from the scale on the side o the tube.

Size and Hemoglobin Content of Red Cells.—These deter minations are used to aid in the diagnosis and therapy o the different anemias. The cell volume, the number of re cells, and the grams of hemoglobin per 100 cc of blood b simple calculation give estimations of the individual red cel (mean corpuscular volume), the volume of hemoglobin i each red cell (mean corpuscular hemoglobin), and the con centration of hemoglobin in each red cell (mean corpuscula hemoglobin concentration).

$$\text{Mean Corpuscular Volume (M.C.V.)} = \frac{\text{Volume packed red cells per 1,000 cc}}{\text{Red cell count, millions per c.mm.}}$$

$$\text{Mean Corpuscular Hemoglobin (M.C.H.)} = \frac{\text{Hemoglobin in Gm. per 1,000 cc}}{\text{Red cell count, millions per c mm.}}$$

$$\text{Mean Corpuscular Hemoglobin Concentration (M.C.H C)} = \frac{\text{Hemoglobin, Gm. per 100 cc} \times 100}{\text{Volume packed red cells, cc per 100 cc}}$$

The volume index is almost the same as the mean corpus cular volume. It is obtained by dividing the volume of packed red cells in per cent of normal by the number of red cells in per cent of normal. The normal volume index is 1.0, but it may range between 0.95 and 1 05. An index above this range indicates that the red cells are larger than normal, while an index below this range indicates that red cells are smaller than normal.

The color index is used in some hospitals in place of the mean corpuscular hemoglobin It determines the weight of the hemoglobin per red cell. It is obtained by dividing the percentage of red cells into the percentage of hemoglobin. The normal color index is 1 0. An index above 1.0 indicates

caused by the *Bacillus typhosus, Streptococcus viridans,* and *staphylococcus aureus.* Of the many drugs and poisons that will produce hemolysis of the red cells, lead, benzol, phenol, sulfanilamide, potassium chlorate, and phenylhydrazine are but a few examples.

Familial Hemolytic Icterus or Congenital Hemolytic Jaundice.—This is an hereditary hemolytic anemia that appears during late childhood, or early adult life, and is a dominant trait passed on from generation to generation according to Mendel's law of heredity. The red cells are thicker than normal, and this is thought to be the reason for their increased fragility in the blood stream. Red cells must be in osmotic equilibrium with the plasma to keep their biconcave oval shape. If there is any alteration in the salt content of the blood, introduction of bacterial poisons, or transfusion of incompatible blood, the cell membrane will break, expelling the hemoglobin (hemolysis). If the red cells are placed in a salt solution of higher concentration than that of plasma, the fluid from the cells is drawn out and they shrink in size and the cell membrane appears wrinkled (crenated) If placed in a salt solution of less concentration than that of plasma, the red cells will absorb fluid, swell and burst, and become hemolyzed ("laked"). This characteristic of the red cells is the principle on which the "fragility test" is based Normal red cells will not become hemolyzed in physiological saline solution (0.9 per cent sodium chloride). Red cells are placed in various dilutions of salt solutions, and the dilution at which the cells become hemolyzed is determined In familial hemolytic jaundice hemolysis begins in the 0 54 per cent and is complete in the 0.36 per cent sodium chloride solution Normal red cells will hemolyze in the 0 32 per cent saline solution The other types of anemias will show some minimal change in the resistance of the red cells to hemolysis, but this is not of any great diagnostic value.

Most of the hemolytic anemias, regardless of cause, will be accompanied by some *degree of jaundice. This is due to the* reduction of the free hemoglobin in the blood into bile pigments which gives the skin and the plasma a yellow color.

Sickle-Cell Anemia.—This is also a hereditary condition but it is strictly confined to the Negro race. The blood appears normal in stained smears, but if a wet preparation as pre-

TYPE OF ANEMIA	M.C. VOL. (CU. μ)	M.C. HB. (γγ)	M.C.HB.C. (%)	MEAN CELL DIAMETER (μ)
Normal blood	80-94	27-32	33-38	6.7-8.0
Normocytic anemia	80-94	27-32	33-38	6.7-8.0
Macrocytic anemia	95-160	30-52	31-38	7.5-9.6
Microcytic anemia	72-79	22-26	31-38	6.5-8.5
Hypochromic anemia	50-71	14-21	21-29	5.8-7.5

Normocytic Anemias.—This type of anemia is characterized by a decrease in the number of red cells, hemoglobin, and blood volume without a change in the size or hemoglobin content of the individual red cell. Normocytic anemia results from sudden loss of blood, destruction of blood cells, and dilution of the blood with plasma (hydremia).

Anemia will always appear after hemorrhage. The degree of anemia depends upon the amount of blood lost. The common causes of sudden acute hemorrhage are severe trauma, ruptured esophageal and gastric varices, duodenal and intestinal ulcers, ectopic pregnancy, tuberculosis (hemoptysis), and uterine bleeding. Immediately after the hemorrhage no change occurs in the cell count or hemoglobin as it requires several hours for the passing of tissue fluids into the blood to increase the blood volume (hydremia). When this takes place, the characteristic blood findings of normocytic anemia will be found. By the second or third day, provided hemorrhage has been checked, the red cell count and hemoglobin shows an increase toward normal Hemorrhage resulting from scurvy and hemophilia has the same features

Normocytic anemia may appear when there is a decrease in blood formation resulting from some interference with the normal function of the bone marrow The bone marrow may become overcrowded with cancer cells or the cells of such diseases as leukemia, Hodgkin's disease, and multiple myeloma which hinder red blood cell formation Toxic substances such as arsphenamine, benzol, and gold salts will inhibit red cell formation. Overexposure to x-rays or radium causes destruction of all the cellular elements in the bone marrow When no apparent cause for the destruction of red blood cells can be found and there is a lack of blood formation, the patient is said to have idiopathic aplastic anemia

Anemia may be due to some weakness of the red cells which permits excessive destruction thereof This is seen in severe septicemias, in infections such as malaria, and in infections

Macrocytic Anemias.—In this type of anemia the red cells are larger than normal with an increase in the quantity of hemoglobin and volume of packed red blood cells. In the peripheral blood nucleated cells, anisocytosis, poikilocytosis, and polychromatophilia (see glossary) are commonly found. The anemia is due to a deficiency or absence of certain enzymes and hydrochloric acid in the stomach necessary for the red blood cells to mature normally. This is called the erythrocyte-maturing factor or intrinsic factor. The anemia may also re-



Fig 42.—Pernicious anemia, blood smear, showing hyperchromia, anisocytosis, poikilocytosis, macrocytosis, and a megaloblast. (×950.) (From Gradwohl Clinical Laboratory Methods and Diagnosis, The C. V Mosby Co)

sult from lack of the necessary maturing factor in the diet (extrinsic factor) The anemia is probably due to combination of the two factors. The diseases causing macrocytic anemia are pernicious anemia, cancer of the stomach, pellagra, fish tapeworm infestation, sprue, and liver disease The specific treatment for pernicious anemia is liver, liver extract, or vitamin B_{12}. The others will respond to liver therapy, but treatment of the cause or nutritional deficiency causes return of normal hemopoietic substances so that liver extract is not required.

viously described is made and allowed to stand for a few minutes, the red cells will become crescent shaped ("sickled"). Some of the patients with sickle-cell anemia will have sudden episodes of hemolysis of the red cells that will produce symptoms which simulate appendicitis.



Fig 41.—Sickled red blood cells *Upper* In a moist preparation, *lower* in the lumen of a blood vessel (From Anderson Synopsis of Pathology, The C V Mosby Co)

Hydremia.—In pregnancy the total volume of the blood is increased. This is probably brought about entirely by increase in the plasma. Thus the formed elements are diluted and there is created a decrease in red cells and hemoglobin concentration ("hydremia"). The condition is sometimes called "physiological anemia of pregnancy"

Anemias in Infants and Children.—The blood-forming system in infants is not as well formed or as stable as that of adults. Therefore infants and children are more likely to develop anemia as a result of poor diet and infection. Also, their growth requirements are increased, and this places an additional strain on the blood-building substances and organs. Some of the anemias that occur in adults may also appear in infants and children, but there are a few which occur only in children.

At birth the normal full-term infant shows a high red cell count (polycythemia). Through a physiological destruction of the red cells in the circulation, the blood count gradually decreases down to a level of anemia from which the infant recovers spontaneously by the end of the first year. During the first week of red cell destruction the infant may develop a mild jaundice noticeable in the skin and the sclerae of the eyes (icterus neonatorum).

Nutritional anemias may result from iron deficiency, due to repeated infections or chronic blood loss, and it is seen in children born of anemic mothers. Nutritional anemia is usually associated with vitamin deficiencies resulting from scurvy, celiac disease, and fibrocystic disease of the pancreas In children anemias due to infection may be true iron deficiency anemia for the appetite lessens and the intake of iron is decreased.

Aplastic anemia, in which all the formed elements of the blood are diminished, may be congenital or acquired. The congenital type is rare. The acquired type may be the result of infection, toxins, or chemicals such as benzol, arsphenamine, or the sulfonamides.

Anemia may result from rapid blood loss following hemorrhage from any cause This is the same type of anemia that occurs in adults.

Erythroblastosis fetalis is a hemolytic disease of the newborn, or it is a familial disease occurring late in fetal life, or shortly after birth, in which excessive destruction of the red cells takes place in the bone marrow, liver, and spleen. This disease rarely develops in the first pregnancy but is more common in the second and third pregnancies. The mechanism of the hemolytic process is caused by substances in the mother's blood called anti-Rh agglutinins. These are transmitted to the

In pernicious anemia liver therapy must be continued throughout life. Shortly after the treatment has begun there will be an increase in the reticulocytes in the blood which will gradually return to normal during convalescence. Associated with the reticulocyte response, the nucleated red cells gradually disappear from the peripheral blood and the blood picture returns to normal

Microcytic Anemias.—In this type there is a decrease in the quantity of hemoglobin and volume of packed cells. The cells are smaller than normal (microcytic), but each cell carries a full load of hemoglobin in proportion to its size. Microcytic anemia is found in chronic infections such as nephritis, syphilis, tuberculosis, osteomyelitis, and rheumatic fever. Treatment consists in removing the cause of the anemia if that is possible, good diet with a high vitamin content, and, in some cases, bed rest.

Hypochromic Microcytic Anemia.—This type of anemia results from a greater decrease in hemoglobin than in the volume of packed red cells due to a reduction of the quantity of hemoglobin in the majority of the cells in proportion to their size, with reduction in size of the individual cells (microcytes). The cause is due to a deficiency of iron in the blood as a result of a diet poor in iron, defective absorbtion of iron from the intestinal tract, and continued slow loss of blood which exhausts the iron reserves of the body Hypochromic microcytic anemia is frequently associated with bleeding peptic and intestinal ulcers, bleeding hemorrhoids, hemorrhagic nephritis, uterine bleeding, cancer of the stomach or intestinal tract, hookworm disease, and, in some cases, pregnancy The anemia is more common in the poorer classes where dietary deficiency is more likely to occur This type of anemia is frequently found in individuals who secrete less than the normal amount of hydrochloric acid in the stomach.

The only sure method of treatment is the administration of iron to replace that which is lost With treatment there is an increase in reticulocytes and regeneration of red cells. If the anemia is associated with vitamin deficiency, vitamin therapy and iron must be combined. If associated with hypothyroidism, iron and thyroid hormone are given.

the ability to engulf foreign material and bacteria. This process is called phagocytosis, and it plays an important part in the defense of the body to injury and infection. The neutrophiles and monocytes are the two cells most frequently seen to be phagocytic. Hemolytic agents that cause hemolysis of the red cells also act on the leukocytes but to a much lower degree.

Number of Leukocytes (Total Leukocyte Count).—Normal blood contains between 5,000 and 7,000 leukocytes per cubic millimeter of blood. It is subject to wide fluctuations in response to physiological and pathological influences

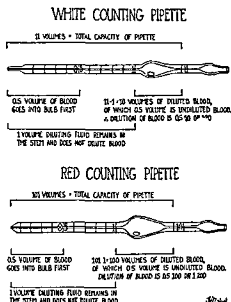


Fig. 43.—Explanation of dilution of blood in red and white counting pipettes (From Gradwohl. Clinical Laboratory Methods and Diagnosis.)

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An increase in the number of white blood cells over 10,000 per cubic millimeter of blood is called leukocytosis whether it is due to a physiological or pathological cause. In the majority of

fetus and hemolyze the infant's red blood cells. The child is born dead or may live only a few hours unless transfused immediately with Rh-negative blood. Further discussion of the factors involved will be taken up under blood grouping and transfusions.

Mediterranean anemia is a congenital and hereditary disease which often affects several children in one family. The etiology is unknown. The bone marrow is hyperactive, but it produces an abnormal red cell which is destroyed by a process of fragmentation. The red cells show an irregular distribution of hemoglobin which is low due to thinness of the cells.

Polycythemia.—Erythrocytosis is an increase in the number of red blood cells and hemoglobin in response to some known cause. It is usually secondary to a lack of oxygen (anoxemia) as occurs in high altitudes with a low oxygen tension, congenital heart disease (patent ductus arteriosus), acquired heart disease (mitral stenosis), and pulmonary disease producing cyanosis.

A relative erythrocytosis may occur in severe diarrhea, vomiting, and burns due to dehydration resulting from the concentration of the plasma. The red cell count and hemoglobin are increased. With treatment and administration of fluids, the blood rapidly returns to normal.

Polycythemia Vera or Erythremia.—This is a true disease of the red blood cell-forming organs of unknown origin. There is a great overproduction of red cells, with the count ranging between 7,000,000 and 12,000,000 cells. The hemoglobin is markedly increased, sometimes reaching the value of 210 per cent (40 grams). The white cell count and platelets are also increased Patients with this disease have a reddish-purple complexion. Treatment is never curative, but reduction in the cell count and blood volume can be accomplished by x-ray and phenylhydrazine, a drug which destroys the red cells

White Blood Cells (Leukocytes)

Morphologically, leukocytes differ from each other much more than the red blood cells do In general, leukocytes are cells with nuclei and cytoplasmic granules of various sizes and types, each appearing in several forms according to their age. Most are capable of moving under their own power and have

tion in which the cells change characteristics and pass through successive stages when they are called myelocytes, juvenile neutrophiles, stab or band neutrophiles, and finally mature neutrophiles. These cells also go by the name of granulocytes. Granular leukocytes are divided into three classes, depending upon the type of granules found in the cytoplasm; that is, neutrophiles, eosinophiles, and basophiles.

Neutrophiles.—These cells are also called polymorphonuclear neutrophiles. They make up approximately 65 per cent of the white blood cells in the adult. At birth the percentage is the same as that of the adult, but it decreases rapidly until the end of the first month (30 to 40 per cent) and remains at this level until the fourth year; then the number gradually increases until the seventh or eighth year, when the normal percentage of the adult is again reached. When stained with Wright's stain, the cytoplasm is pale pink, containing lavender granules; the nucleus stains purple and is horseshoe shaped and divided into two to six lobes. The more mature the cells, the more lobulated the nucleus becomes. The neutrophiles are divided into four groups.

1. **Myelocytes:** These are very young cells rarely found in normal blood. They appear in very acute infections and are numerous in myelogenous leukemia. The nucleus is round and stains purple The cytoplasm is dark blue and filled with lilac granules

2. **Juvenile neutrophiles:** These are less mature neutrophiles in which the nucleus has not yet become lobulated and has a sausage shape.

3. **Stab or band neutrophiles:** These are more mature neutrophiles in which the nucleus is more ribbonlike in appearance and ready to become lobulated.

4. **Segmented neutrophiles:** These are the mature neutrophiles and they have an irregular multilobulated nucleus.

An increase in the number of neutrophiles is called neutrophilia. This condition is a common finding in acute pneumonia, appendicitis, otitis media, peritonitis, scarlet fever, and the other diseases caused by pyogenic bacteria, streptococci, staphylococci, etc Neutrophilia may also be found in noninfectious conditions such as acute hemorrhage, malignant tumors, and convulsions.

cases leukocytosis is due to an increase in the neutrophiles, but sometimes it is due to an increase in lymphocytes or monocytes

Physiological leukocytosis is due to an increase in the number of neutrophiles occurring after meals and after heavy exercise, during hard labor, during changes in body temperature and posture, and in the late stages of pregnancy, and in hemoconcentration. In the newborn the leukocyte count is usually 20,000 to 25,000, but during the first week of life it falls to 10,000 to 15,000, and as the child matures the count gradually drops to the normal adult level.

Leukocytosis is commonly a result of circulatory disturbances as occurs in paroxysms of rapid heart action and epileptic convulsions. It is important that leukocytosis from a physiological cause is not mistaken for one due to infection.

In pathological leukocytosis there is a change of the ratio of the different cell types, resulting in an increase in one type of cell. In the majority of cases the increase is in the neutrophiles, and less often in the eosinophiles, lymphocytes, or monocytes In leukemia there is a leukocytosis (20,000 to 100,000) not only of the normal cells, but also of the immature leukocytes not present in normal blood. Leukemia is a separate disease involving the hematopoietic system (bone marrow, spleen, liver, and lymph nodes)

A decrease in white cells below 5,000 is called leukopenia It is found most often in virus infections such as measles, influenza, and German measles A few bacterial infections, such as typhoid and undulant fever, produce leukopenia It is also associated with anemia due to x-ray radiation and benzol poisoning. Leukopenia associated with acute overwhelming infections is a grave prognostic sign

Differential Count.—The microscopic examination of stained blood smears is one of the most important laboratory procedures used in making a diagnosis

To make a blood smear, a drop of blood is placed on a glass slide and spread evenly with the flat edge of another glass slide The smear is allowed to dry, then it is stained with Wright's stain, placed under the microscope, and studied under high power The white cells are counted and recorded in their individual classes

Leukocytes are classified by their differences in morphology The neutrophiles are derived from large primitive cells (myeloblasts) that lack granules and are located in the bone marrow. The myeloblast cells go through a process of matura-

An increase in the monocytes (monocytosis) occurs in syphilis, undulant fever, typhoid fever, tuberculosis, and monocytic leukemia.

Diseases of the Leukocytes

In the majority of cases leukocytosis is due to the response of the body as a defense mechanism to fight infection and to help protect the body against injury. As such it is part of the defense mechanism described in Chapters 4 and 7. Leukocytosis may also result from primary diseases of the blood-forming organs which are of unknown etiology. Only the more common and important diseases will be discussed here. These are the various types of leukemia, agranulocytosis, and infectious mononucleosis.

Leukemia.—Leukemia is a disease of the organs that form the white blood cells. These organs (lymph nodes, bone marrow, spleen) become overactive and produce an abnormal number of immature white cells. These white cells are so young that they are incapable of serving any useful purpose. Leukemia differs from malignancy elsewhere in the body in that the circulating blood contains the abnormal cells and acts as the medium for disseminating them There are three types of leukemia; myelogenous (neutrophilic), lymphatic, and monocytic. These may be acute or chronic.

The most common findings in the peripheral blood is a leukocytosis ranging from 30,000 to 50,000. The stained blood smear shows the majority of the white blood cells to be immature, with a proportionate increase in the few normal cells present. An anemia of moderate degree is usually present. Occasionally leukemia is accompanied by leukopenia, and the total number of white cells is decreased (1,000 to 2,000) with the differential smear showing the majority of the cells to be the immature forms. This is called aleukemic leukemia.

Treatment of leukemia may prolong life but it is not curative. The diagnosis is made by peripheral blood and bone marrow studies

Acute myelogenous and lymphatic leukemia are fulminating diseases that have a sudden onset and run a short fatal course. They are more common in children than in adults. They are characterized by symptoms of extreme weakness, ul-

The main function of the neutrophiles is to combat infection.

Eosinophiles.—These constitute 1 to 4 per cent of the total number of leukocytes. The granules in the cytoplasm are larger and more coarse than those of the neutrophiles and stain bright pink. An increase in the eosinophiles (eosinophilia) may be due to allergic conditions (asthma, hay fever), parasitic diseases (trichinosis), skin diseases (psoriasis, herpes zoster), infectious diseases (scarlet fever, rheumatic fever), and miscellaneous conditions such as Hodgkin's disease and Addison's disease. Occasionally eosinophilia is seen after eating raw liver and after the injection of vaccines.

Basophiles.—These constitute 0.5 per cent of the total leukocyte count. They are smaller than the neutrophiles and are characterized by coarse, deep blue granules. They have very little diagnostic value. They are increased in myelogenous leukemia.

Lymphocytes.—Lymphocytes and monocytes are also called agranulocytes because they do not contain granules in their cytoplasm This is a relative classification as the monocytes contain a few small granules

Lymphocytes are derived from the lymphatic tissue spread throughout the body (lymph nodes, spleen). In infants and children the total number of lymphocytes is higher than in adults. The nucleus stains blue, is round or indented, and almost fills the entire cell, leaving only a small amount of light blue cytoplasm They constitute 25 to 35 per cent of the total leukocyte count.

The lymphocytes are increased without an increase in the total number of leukocytes (relative lymphocytosis) in measles, German measles, mumps, malaria, hypothyroidism, influenza, and typhoid fever. In whooping cough (pertussis) the total leukocyte count is high (15,000 to 20,000), with the majority of the cells (80 per cent) being lymphocytes.

Monocytes.—These comprise 4 per cent of the total white count. Their exact origin is not known, but it is thought to be from large cells in the bone marrow and spleen. They are larger than the lymphocytes, have an oval to horseshoe-shaped indented nucleus that stains light blue, and the cytoplasm stains sky blue and contains fine, red-colored granules.

300. Some cases have developed in response to the use of certain drugs—amidopyrine and the sulfonamide drugs. The red cells and hemoglobin are usually not affected. These drugs hinder the normal maturation process of the myeloblasts; the defense of the body for bacteria is reduced and infection of the mucous membranes and other body organs is common and frequently fatal.

Infectious Mononucleosis (Glandular Fever).—This is a benign disease, protean in nature, characterized by acute onset with sore throat, fever, and enlargement of the lymph nodes, particularly the cervical nodes. The etiology is unknown, but it is thought to be a virus disease. The leukocyte count may be as high as 50,000 cells, but it usually ranges between 15,000 and 25,000, or it may be normal or low with an atypical type of lymphocyte as the predominant cell. The lymphocytes may make up 80 per cent of the total white count. The patient usually recovers within a few weeks, but the elevated white count and enlarged lymph nodes may persist for months. It is important that this disease be differentiated from lymphatic leukemia as the blood findings are similar.

Heterophile Antibody Test (See p. 355): In infectious mononucleosis there are in the blood antibodies which will agglutinate normal sheep cells. These antibodies may be found also in certain other diseases, but the titer is not as high as in infectious mononucleosis, and it is, therefore, used as a diagnostic test in this condition and is called the heterophile antibody test

Platelets (Thrombocytes)

Platelets are small, oval, colorless, immobile bodies derived from the cytoplasm of large giant cells (megakaryocytes) in the bone marrow. When stained with Wright's stain they appear as small irregularly shaped cells with a red nucleus and blue cytoplasm They vary from 2 to 4 μ in diameter (one-half to one-third the size of a red cell). Numerous methods for counting platelets have been devised, but none is too accurate. Platelets may be counted on the routine differential smear to obtain a general idea of the number present. On the average, there are 1 to 4 platelets per high-power field or 1 platelet to every 30 to 50 red cells. A more accurate count is

cerations and bleeding of the mucous membranes, signs of fever, generalized lymph node enlargement, and marked anemia. Examination of the blood shows an elevated white cell count sometimes reaching the level of 500,000 cells. The predominating cell in myelogenous leukemia is the myeloblast, while in lymphatic leukemia it is the lymphoblast.

Chronic myelogenous leukemia is more common in adults (20 to 50 years), and it is rarely seen in children. It affects males more often than females. The onset is insidious. The most frequent physical finding is an enlarged spleen. Examination of the blood shows a high white count, 15,000 to 20,000 to 1,000,000 cells. The differential count reveals a high per cent (95 per cent) of immature forms of all the cells in the granulocyte series — myeloblasts, myelocytes, eosinophiles, basophiles, etc The red cells and hemoglobin are reduced. Some of these patients may live for years if the disease is controlled by radiation of the spleen with x-ray, but as a rule life expectancy is only a few years.

Chronic lymphatic leukemia is more common in males than females between the ages of 45 and 65 years. It is rarely seen in children It is characterized by a swelling of all the lymphatic tissue in the body resulting in an increased production of lymphocytes The predominating cell is the small lymphocyte The count ranges between 50,000 and 1,000,000.

Monocytic leukemia is rare The predominating cells are monocytes in various stages of development.

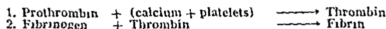
Atypical forms of leukemia have been described according to the predominate cell found in the blood—eosinophilic leukemia and basophilic leukemia.

During the acute stages of certain diseases in which there is a leukocytosis, such as pneumonia, hemolytic jaundice, and in some anemias in children, the blood-forming organs may be placed under such a severe strain that numerous immature granulocytes will appear in the blood. This is called a "leukemoid reaction." The blood picture resembles leukemia, and it is important that the two are differentiated

Agranulocytosis or Malignant Neutropenia.—This is a disease of unknown origin in which there is a complete absence or decrease of the neutrophiles with a marked depletion of the lymphocytes and monocytes, giving a total white count of 200

Coagulation

Coagulation (clotting) is a process in which the blood changes from a liquid into a soft jellylike mass. Many theories have been proposed concerning the physical and chemical changes that take place when blood clots. Present evidence seems to favor the enzyme theory which involves several substances combined into two reactions. These substances are prothrombin formed in the liver, calcium in the blood, thromboplastin from the platelets, and fibrinogen, a complex protein in the blood. The following reaction takes place:


1. Prothrombin + (calcium + platelets) ⟶ Thrombin
2. Fibrinogen + Thrombin ⟶ Fibrin

The fibrin forms small interlacing strands that trap the red blood cells and platelets until the blood changes from a thick fluid into a firm, elastic, tough blood clot. Normally the process of clotting is a defense mechanism against injury and against the loss of blood through injury. Cut or torn blood vessels allow blood to escape. With the formation of the fibrin mesh, this escape is gradually blocked. As soon as the blood clot within the lumen of the blood vessel becomes attached to the vessel wall and strong enough to withstand the intravascular blood pressure, bleeding will cease.

Thromboplastin, the ferment produced by the platelets, will react only in the presence of calcium. Anticoagulants such as sodium citrate and potassium oxalate combine with the calcium and hinder its reaction. Coagulation is thereby prevented. This is of practical value in laboratory work

The serum and plasma portion of the blood have already been described.

Coagulation or Clotting Time.—There are numerous methods of determining the clotting time of blood. Only two methods will be described here.

The normal time varies from 1 to 5 minutes.

obtained by using the brilliant cresyl blue moist preparation method. Normal blood contains from 250,000 to 500,000 platelets per cubic millimeter. The platelets are concerned with the coagulation of blood and will be discussed under coagulation.

An increase in platelets (thrombocytosis) is not used as an aid to diagnosis but is more of academic interest since it occurs in so many conditions. Thrombocytosis occurs after tissue injury, hemorrhage, anoxemia, bone fractures, and splenectomy. It accompanies such diseases as acute infections, polycythemia, Hodgkin's disease, sickle-cell anemia, and chronic myelogenous leukemia. When the thrombocytosis is marked and of long duration, intravascular thrombosis and infarction may occur as a result of the clumping of the platelets.

A decrease in platelets (thrombocytopenia) is usually secondary to some other condition. Thrombocytopenia is important since it is usually associated with a tendency to bleed. This is particularly true if the platelet count becomes very low (60,000 to 100,000) Platelets are decreased in severe infections as miliary tuberculosis, following the use of arsphenamine, gold salts, poisoning due to benzol, and after excessive x-ray radiation. Thrombocytopenia is also found in malignancies that invade the bone marrow, uremia, pernicious anemia, leukemia, and aplastic anemia.

An infection characterized by hemorrhages into the skin is called purpura. This is a frequent finding in diseases that cause a thrombocytopenia, but it is also found in many diseases not associated with a decrease in the platelet count. This latter condition is called symptomatic purpura and is found in numerous infections — tuberculosis, typhoid, malaria, influenza, cerebrospinal meningitis, subacute bacterial endocarditis, scurvy, nephritis, and some allergic disorders

Primary thrombocytopenic purpura or idiopathic thrombocytopenic purpura is a disease that is found most commonly in children. The cause of the disease is unknown It is characterized by attacks of bleeding or purpura of variable duration. The platelet count during an episode of bleeding is usually below 100,000. The disease may be acute or chronic. Death may occur during the first attack. Treatment consists of removal of the spleen or x-ray radiation therapy.

the clotting time indicates the concentration of this substance. In normal individuals the blood contains a slight excess of prothrombin and blood clots in 20 to 25 seconds. Bleeding will occur if the prothrombin is reduced to less than 20 per cent of normal. This can be achieved by means of dicumarol, a drug which is used when thrombosis is a complication to be feared.

Blood Groups and Blood Transfusions

Before the turn of the nineteenth century many workers had recognized that mixing the serum of one person with the red blood cells of another often resulted in hemolysis of the red blood cells. In 1901, Landsteiner recognized the importance of classifying the blood according to this principle. It was not until 1907 that Jansky clearly separated the four groups used today. Several classifications have been reported, but the principle of each is the same. The simplest classification is that of Landsteiner which uses the terms AB, A, B, O. The classification is based upon the principle that the red blood cells contain substances called antigens and the blood serum contains substances called antibodies. The two antigens of the red blood cells are called agglutinogens. They are designated by the letters A and B The two antibodies of the blood serum are called agglutinins. They are designated by the letters alpha and beta or simply a and b. The four blood groups are separated from each other according to the way the antigens and antibodies mix when added together. The agglutinin (alpha-a) reacts with the agglutinogen B to produce clumping and hemolysis, and the same reaction occurs with the mixing of agglutinin (beta-b) and aggultinogen B. Since clumping and hemolysis occur when antibody a and antigen A, etc., are mixed, it would be impossible for these to exist at the same time in the blood of a normal individual. It is incompatible with life. Therefore the four blood groups are classified as outlined in the chart below.

TYPE	AGGLUTINOGEN	AGGLUTININ
AB	A and B	None
A	A	b
B	B	a
O	None	a and b

Group A serum contains beta (b) agglutinins and group B serum contains alpha (a) agglutinins; group AB contains A

Clotting time is prolonged in hemophilia, jaundice, and some anemias.

Capillary Fragility Tests (Rumpel-Leede Phenomenon)

In such diseases as scurvy (lack of vitamin C) and thrombocytopenic purpura, the small capillaries become more fragile than normal and rupture. When the small blood vessels rupture, small hemorrhages (petechiae) are seen in the mucous membranes and skin. The easiest method of testing capillary fragility is to apply the blood pressure cuff on the arm and inflate it for five minutes just above the diastolic pressure. In normal persons one or two petechiae may appear in the skin below the cuff. If the test is positive, as occurs in scurvy and purpura, numerous small hemorrhages will appear in the skin. By the suction cup method, a special type of cup in which the pressure can be controlled is placed on the skin and the pressure reduced Healthy individuals have a capillary resistance ranging between —20 to —35 cm. mercury If capillary fragility is increased, a value below 20 is obtained. The venom skin test consists of injecting intradermally 0.1 cc of 1:3,000 sterile moccasin snake venom. A control injection of normal saline is done in the other arm. If the test is positive, a hemorrhage 1 cm in diameter is found one hour after the injection at the site of the injection.

Skin Bleeding Test

This test determines the length of time required to stop bleeding after the small capillaries of the skin have been cut with a lancet. The incision is made 2 to 3 mm. deep. This is a determination for capillary bleeding time only and not for bleeding from larger vessels. In normal individuals bleeding will cease in one to three minutes In scurvy, leukemia, hemorrhagic diseases of the newborn, and purpura the bleeding time is prolonged.

Prothrombin Time

Prothrombin is a substance formed by the liver by vitamin K. Prothrombin is essential for the formation of another substance, thrombin, which is required for the coagulation of blood. If all the factors connected with the coagulation of blood (p. 257) are controlled except the prothrombin contents,

and B agglutinogens in the red blood cells, but the serum lacks the alpha (a) and beta (b) agglutinins; group O lacks the agglutinogens A and B in the red cells, but the serum contains both the alpha and beta agglutinins. In white Americans the groups O (43 per cent) and A (40 per cent) are the most common. Groups B (7 per cent) and AB (10 per cent) are less common

Before a blood transfusion can be given, the individual donating the blood (donor) must be matched with the individual who is to receive the blood (recipient). The blood of each person is typed and classified. The technique of blood typing consists of mixing a loopful of red cells with a drop of known sera A and B and looking under the microscope for agglutination. This test is performed with red blood cells from the donor and recipient. The blood type and grouping of an individual is more easily understood if the chart outlined below is followed. The plus sign designates clumping and hemolysis of the red cells, the negative sign designates no clumping.

RED CELLS TESTED	A SERUM	B SERUM
O	−	−
B	+	−
A	−	+
AB	+	+

Since the cells of group O are not agglutinated by either A serum or B serum, it can be given to anyone. Individuals belonging to group O are called universal donors. The plasma of individuals belonging to group O contains the alpha and beta agglutinins, but they are so dilute that they are negligible. Since the blood of individuals in group AB lacks the alpha and beta agglutinins, they may receive blood from an individual belonging to any of the four groups (universal recipient). However, transfusion reactions have occurred and it is better to use the same type of blood (AB) or group O in transfusing a universal recipient

Individuals who belong to the same group as the recipient are not always compatible blood donors. Sometimes the blood of an individual will agglutinate the red cells of an individual belonging to the same blood group As added protection the red cells of the donor are mixed with the serum of the recipient (cross-matching) and observed for clumping. If no clumping or hemolysis occurs, the blood is compatible.

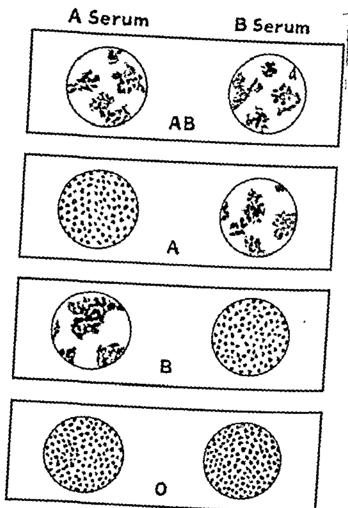


Fig 44.- Technique of blood grouping To determine the blood group to which a person belongs, a drop of his red blood cells which have been diluted with salt solution is placed on each end of a slide, and the blood serum of a person belonging to group A is mixed with one drop of the diluted cells, and a drop of the blood serum of a person belonging to group B is mixed with the other drop Pictured above are the effects of these serums on the cells of persons belonging to the different blood groups (From Carter Principles of Microbiology, The C V Mosby Co)

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The transfusion of incompatible blood is usually associated with an onset of symptoms after the introduction of only a few cubic centimeters of blood. If the transfusion is stopped immediately, no harm results. The most common symptoms and signs are anxiety, flushing of the face, precordial oppression and pain, dyspnea, cyanosis, increase in pulse and respiratory rate, and hives. More severe reactions produce a chill followed by a rise in temperature, shock, coma, and maybe death. A transfusion reaction indicates that the red cells of the donor are clumping and hemolyzing in the plasma of the recipient. After the transfusion reaction the hemoglobin from the hemolyzed red cells will appear in the urine (hemoglobinuria). If the reaction is severe, jaundice and anuria may occur.

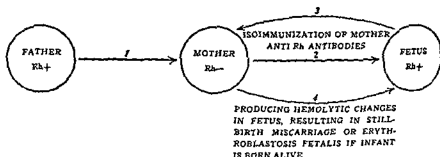


Fig 45.—Diagram of the Rh phenomenon in pregnancy (From Gradwohl *Clinical Laboratory Methods and Diagnosis*.)

Occasionally transfusion reactions will occur even if the typing and cross-matching are correct This is particularly true in individuals who receive transfusions frequently or in women who are pregnant or receive post-partum transfusions These reactions are due to another agglutinogen called the Rh factor It received its name from the Rhesus monkey in which it was first demonstrated and is present in the red cells of 85 per cent of all persons, designated Rh positive, and absent in the other 15 per cent, designated Rh negative The plasma does not contain an Rh agglutinin. Rh agglutinins can occur only in Rh-negative persons, and they are never normally present. If an Rh-negative person receives repeated transfusions with Rh-positive blood, he develops antiagglutinins (antibodies) which will agglutinate the Rh-positive red cells, causing a transfusion reaction.

The Rh factor is of particular importance during pregnancy. *The Rh factor is a Mendelian dominant. According to this, if* the father is Rh positive, the fetus in utero is Rh positive if the mother is Rh negative. If the mother is Rh negative, a few of *the fetal red cells may filter into the maternal circulation and* produce antiagglutinins (antibodies) in the maternal plasma. This plasma may in turn filter back into the fetal circulation *and destroy the Rh-positive red cells of the fetus,* causing erythroblastosis fetalis with anemia and jaundice. If this woman is transfused during her pregnancy or a short time *after delivery with Rh-positive blood, a severe transfusion re-*action will occur due to the destruction of the Rh-positive cells. If she is transfused with Rh-negative blood, no reaction will occur. *It is important to remember that the mother or child* should not be transfused with the father's blood.

Blood Banks

Most hospitals now carry a surplus supply of blood that is available for transfusions at any time. It is usually blood obtained from voluntary donors. Blood is drawn from the donor into a sterile flask containing an anticoagulant (sodium citrate) and placed in a refrigerator The blood can be kept in the refrigerator for approximately ten days before hemolysis of the red cells is extensive enough to make it unsuitable. When this happens, the plasma can be removed and frozen at 4° C. and kept for an indefinite period.

Before blood is drawn from the donor he is given a physical examination and questioned about recent infections, malaria, or blood dyscrasias At the same time a small sample of blood is obtained which is used for blood typing, white and red cell count, hemoglobin determination, and a serological test for syphilis. The presence of disease makes any donor unsuitable The blood and plasma obtained from the donor must be handled with great care so that it is kept sterile and free from any form of contamination

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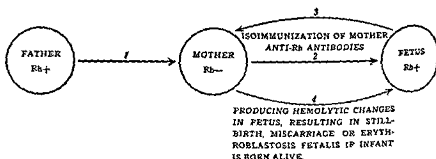


Fig. 15.—Diagram of the Rh phenomenon in pregnancy. (From Gradwohl *Clinical Laboratory Methods and Diagnosis*.)

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the kidneys. The most common causes for an elevated N. P. N. are renal insufficiency (nephritis), fevers in which there is an excessive *breakdown of proteins, prostatic obstruction,* intestinal obstruction, dehydration due to excessive vomiting and diarrhea, and hemorrhage. Dehydration causes concentration of the fluid portion of blood and an increase in the N. P. N. In hemorrhage of the gastrointestinal tract the increase in the N. P. N. is due to the reabsorption of the proteins into the blood from the blood in the tract.

If the N. P. N. reaches a level of 120 to 140 mg, symptoms of uremia may develop. These are headache, muscular twitching, vomiting, restlessness, drowsiness, convulsions, and finally coma.

Urea Nitrogen.—Most of the N.P.N. is excreted in the form of urea. It is formed in the liver and excreted by the kidneys. The normal blood level is 12 to 15 mg. per 100 cc. of blood, or 45 to 65 per cent of the total N P. N. Urea nitrogen levels are elevated in advanced kidney disease due to marked urinary retention and the conditions mentioned above that cause an increase in N. P. N.

Uric Acid.—Uric acid is a product derived from the breakdown of purines taken in the food (liver, kidney, pancreas, lima *beans) and from the breakdown of nuclear material in the* cellular structures of the body. The normal range is 1 to 3 mg per 100 cc of blood. A physiological increase may occur in normal persons during muscular exercise, starvation, and the late stages of pregnancy High blood uric acid levels are also associated with leukemia, polycythemia, toxemias of pregnancy, nephritis, lead poisoning, and other conditions associated *with a high N. P. N level*

Creatinine.—This substance is formed from another substance, creatine, found in the muscles. The normal valves are small—1 to 2 mg per 100 cc of blood. High blood levels are usually *found in nephritis and conditions producing retention* of N P. N. An elevated level of 5 mg. is an indication of a poor prognosis, usually with a fatal outcome.

Plasma Proteins (Total Proteins).—The three main proteins in the plasma are albumin, globulin, and fibrinogen. When the values for each are added, they indicate what is called the total protein. The total protein for human plasma is 7.1 grams

CHAPTER 19

LABORATORY DIAGNOSIS (Continued)

CLINICAL BLOOD CHEMISTRY

Disease of the various organs of the body may change their normal metabolic function in such a manner that there is an accompanying change in the chemical constituents of the blood. Chemical analysis of the blood determines these changes and is often important in making the diagnosis and in observing the course of diseases and their response to treatment. The blood for the tests is usually obtained by venepuncture, and in the majority of cases the blood is mixed with an anticoagulant (e g., potassium oxalate) to prevent clotting. Tests for the determination of blood calcium and bile pigments are performed on serum.

Nitrogenous Constituents of the Blood.—The nitrogen of the blood is present in two forms: that in the protein molecule and that in the products which are the end result of protein catabolism and are waste products The latter group is called the nonprotein nitrogen (N P. N.) and is excreted by the kidneys. The amount of N. P. N. formed in the body depends upon the dietary intake of protein, the rate at which proteins are destroyed in the body (catabolism), and the ability of the kidneys to concentrate the nitrogenous products and to secrete urine.

Nonprotein nitrogen is the nitrogen contained in urea, uric acid, and creatine. These are extracted from the blood or plasma by adding trichloracetic acid which precipitates the proteins. The proteins are removed by filtering, and the filtrate left is used to determine the N. P N. Normal blood contains 25 to 40 mg. per 100 cc of blood. In general, a N. P. N. above 40 mg. is considered pathological The N. P N level represents the balance between the total amount of nitrogenous waste products entering the blood and the amount being excreted by

breakdown of body protein and fat, while the largest p comes from the carbohydrate in food ingested during me The carbohydrate in food after reaching the gastrointesti tract is broken down into glucose, which is absorbed and c ried by the blood to the liver. Here it is stored as glycog Another portion of the glucose is carried to the body tiss where it is used as nourishment for normal metab processes.

Blood sugar determinations are carried out on fasting ven blood samples taken early in the morning before breakf Determinations may be done on capillary blood obtained sticking the tip of the finger. This is called the micro meth It is important that the blood sugar determination be d as soon as possible. If the blood sample is allowed to sta the blood sugar will break down (glycolysis) and the resu obtained will not be the correct value. The normal bl sugar values range from 70 to 100 mg. per cent per 100 cc blood, with an average of 85 mg per cent.

Elevated blood sugars (hyperglycemia) are found m often than decreased blood sugars (hypoglycemia) A phys logical hyperglycemia occurs after meals and is called p prandial hyperglycemia. Other conditions causing physiolo cal hyperglycemia are emotional upset, ether anesthetics, a the premenstrual period. In these conditions the blood su rarely exceeds 140 mg. per cent

Pathological hyperglycemia (160 mg. or more) is found hyperthyroidism, brain tumors and injuries, hypertension sociated with arteriosclerosis, cerebral hemorrhage, and d betes mellitus. The most important disease is diabetes mellit since it is due to insufficient insulin This lack of insulin sults in improper storage of glycogen by the liver, failure oxidation of glucose by the body tissues, and failure of su to be removed from the blood stream The end result is excessive accumulation of sugar in the blood. When the le of sugar in the blood exceeds the threshold of 160 to 180 m the kidneys can no longer hold it back and it is excreted in urine (glycosuria) It is readily understood how import blood sugar determinations are in regulating the dosage insulin and diet when treating diabetics.

In acute pancreatitis a blood sugar level of 250 to 400 mg. p cent may be found without finding sugar in the urine. T

per 100 cc of plasma. The ratio of albumin to globulin is called the A/G ratio. The normal A/G ratio is 1.5 to 1.0. The functions of the three proteins are numerous, the important ones being to help maintain the acid-base balance, to maintain the normal liquidlike consistency of the blood (viscosity), and to serve as reserve protein upon which the body can call when the protein in the diet is inadequate. Fibrinogen is important in the clotting mechanism of the blood. The globulin fraction is associated with the process of immunization, the exact mechanism of which is not understood. All three proteins act together in association with the salt content of the blood to help maintain the osmotic pressure in the blood vessels which in turn helps regulate and keep a normal balance of water in the body. If the total protein of the plasma is reduced either by lack of formation due to insufficient dietary intake or disease, or because of loss through kidney excretion as occurs in kidney disease (nephritis), the tissues of the body retain water and edema is the end result. In general, the subcutaneous tissues will not begin to show signs of edema (pitting of the skin on pressure) until the protein level reaches 5.0 or 5.5 grams.

The majority of the pathological states which affect the body roteins will cause a reduction in plasma proteins rather than n increase. Elevations of the plasma proteins may be seen in ıch conditions as multiple myeloma, kala-azar, leprosy, farlvanced cancer, Boeck's sarcoid, and excessive diarrhea and omiting in which the loss of fluid from the blood causes a ıysiological concentration of the plasma. The total proteins ay reach a level of 10 to 12 grams. The increase in total prons in diarrhea and vomiting show a normal A/G ratio, while the others there is a reversal of the A/G ratio due to an inease in the globulin while the albumin remains normal.

In diseases of the kidneys such as nephrosis, glomerulophritis, and amyloidosis, the protein lost is albumin. This only produces a decrease in the total proteins, but also a resal of the A/G ratio since there is more albumin lost than bulin.

roteins may be decreased in liver insufficiency, liver ase, such as cirrhosis of the liver, and congestion of the r resulting from heart failure

ıgar or Glucose.—Blood sugar (glucose) in the body is ved from two sources: a small amount comes from the

Elevations of blood cholesterol (hypercholesteremia) are found in hypothyroidism, nephrosis, obstructive jaundice, diabetes mellitus, and pregnancy. The elevated blood cholesterol in diabetes is thought to be associated with the arteriosclerosis which has a tendency to appear earlier in persons with diabetes than it does in normal individuals.

Cholesterol is decreased in hyperthyroidism, intestinal obstruction, and pernicious anemia during a relapse. A decrease in the blood cholesterol is considered to be of diagnostic importance in hyperthyroidism.

Amylase.—This is a starch-digesting enzyme secreted by the salivary glands, pancreas, and the liver. The normal level ranges between 80 and 150 mg. per 100 cc of serum by the *Somogyi method* *Elevated levels are found in acute pancreatitis* and obstruction of the common bile duct by gallstones. Abnormally low values are found in toxemias of pregnancy, liver abscess, cancer of the liver, cirrhosis of the liver, pneumonia, and hepatitis.

Calcium.—Most of the calcium in the body is contained in the skeletal system Small amounts are found in the blood and body tissues The normal range for calcium in the serum is 9.0 to 11.5 mg. per cent. The main functions of calcium are to aid in the clotting of blood and in the growth of bones. The parathyroid glands control the calcium level of the serum Disease of the parathyroid glands is usually associated with an alteration in the blood calcium level In hyperparathyroidism the glands become overactive, and this results in a removal of calcium from the bones with pathological deposition of the calcium in the soft tissues (muscles). The blood calcium level becomes elevated (14 to 18 mg. per 100 cc), while the blood phosphorus decreases. There is also loss of calcium through the kidneys into the urine The loss of calcium from the bones produces multiple small cystic areas in the bones This weakens them and renders them more susceptible to fracture. Spontaneous fractures are common in hyperparathyroidism. In multiple myeloma and cancer with metastases to the bones, the blood calcium is elevated with a corresponding decrease in the blood phosphorus.

Low serum calcium levels (7.0 mg or less) are found in such diseases as rickets, celiac disease, osteomalacia, toxemias of

reason is not known why sugar in this case can rise above the threshold level without spilling into the urine.

Hypoglycemia occurs after prolonged, excessive muscular exercise, in starvation, Addison's disease, pituitary tumors, and thyroid deficiency (myxedema, cretinism). When the blood sugar level reaches 50 mg. per cent, symptoms of hypoglycemia appear. These are weakness, nervousness, sweating, mental confusion, and trembling of the muscles.

To test for an abnormality in the metabolism of glucose, a glucose tolerance test must be done. It is used to determine the amount of sugar left in the blood following the ingestion of a known amount of sugar at the end of a certain time interval. The test is simple and easy to do.

All food is restricted after the evening meal at 7:00 P.M. At 7.00 A.M. the next morning a sample of blood is drawn for the fasting blood sugar. Then the patient is given 100 Gm. of sugar dissolved in water. Then blood samples are drawn at the end of one-half, one, two, three, and four hours or at other stated times. Urine specimens are collected when the blood samples are obtained. The blood sugar determinations are calculated and a graph made of levels of blood sugar found. The amount of sugar excreted is calculated from the urine specimens.

In normal individuals the blood sugar level will rise to 150 to 170 mg. per cent in one hour and then rapidly fall, to return to the fasting level in two hours (80 to 100 mg. per cent). Most patients with a normal glucose tolerance do not excrete sugar in the urine. In patients with diabetes the blood sugar steadily increases to a higher level, reaches the peak by the end of two hours, and then gradually decreases. By the end of five hours it returns to the normal fasting blood sugar level. While the blood sugar concentration is above the threshold level, sugar will appear in the urine. In general, a normal glucose curve rules out diabetes In hyperthyroidism and hyperpituitarism the blood sugar curve shows a moderate elevation.

Diseases producing excessive amounts of insulin, such as Addison's disease and pancreatic tumors, produce a curve in which the blood sugar falls below the normal fasting blood sugar. Overdosage of insulin during treatment of a person with diabetes will produce the same type of curve. If severe, the blood sugar becomes so low that symptoms of hypoglycemia occur.

Cholesterol.—Cholesterol is a fatty alcohol found in small amounts in all the tissues and body fluids. The normal range is 150 to 250 mg. per cent.

mucous membranes, and sclera of the eyes) become stained with a yellow tint due to the excessive accumulation of bile pigment. This condition is called jaundice, or icterus. Since the human eye cannot detect changes in intensity of the jaundice, it is necessary to run tests to determine the concentration of bile pigment in the blood.

Jaundice is usually divided into three types, depending upon the cause. It may be due to damage of the liver which prevents it from excreting bilirubin which is produced in normal amounts. This type of jaundice occurs in hepatitis and cancer of the liver. Jaundice may be due to excessive breakdown (hemolysis) of the red blood cells, as in malaria, pernicious anemia, and hemolytic anemia. Jaundice may be due to obstruction of the common bile duct which results in a backing up of the bile into the gall bladder, liver, and the blood.

To test for an increase in the bile pigment in the blood, the patient's serum is matched with various known standards and the result is reported in units. Normal blood contains 3 to 8 units. If the blood contains 8 to 15 units, the patient is said to have latent or subclinical jaundice, as this amount of bile pigment in the blood is not enough to make the yellow tint of the skin visible to the human eye. If the bile pigments of the blood exceed 15 units, the jaundice becomes visible

To determine if the jaundice is due to damage of the liver, obstruction of the common bile duct, or excessive hemolysis of the red cells, the van den Bergh test must be done This test determines whether the serum bilirubin has been modified by the liver cells. It consists of adding Ehrlich's diazo reagent to the blood serum Normally no reaction is seen until alcohol is added Normal blood serum will produce a reddish-violet color This reaction is called an indirect reaction and is due to the presence in the serum of bilirubin which has not yet been acted upon by the liver cells. The indirect reaction indicates that jaundice is present due to excessive hemolysis of the red blood cells Jaundice due to liver damage or obstruction of the common bile duct produces a direct reaction, the color change takes place without the addition of the alcohol to the blood serum This reaction is caused by the presence in the blood of bilirubin which has passed through the liver cells.

Chlorides.—Chlorides are present in all body tissues and fluids The main function of sodium chloride is to maintain the

pregnancy, and nephritis. The most outstanding symptom of a low serum calcium is tetany.

Phosphorus.—Phosphorus is present in the blood in several forms. It helps in the formation of new bone and in the maintenance of the calcium balance and of a normal acid-base balance in the blood. There is a direct relationship between calcium and phosphorus. In general, when the serum calcium level is increased, the phosphorus level is decreased, and when the serum calcium is decreased, the phosphorus is increased. Normal blood levels vary between 3.0 and 3.5 mg. per cent in adults and 1.0 to 7.0 per cent in children.

Low phosphorus levels are found in rickets, osteomalacia, and hyperparathyroidism. In the latter two conditions the calcium level may be slightly elevated or normal. Low phosphorus levels appear to hinder the formation of new bone by preventing the deposition of calcium phosphate. In healing fractures, the phosphorus level is increased, while the calcium level is normal.

High phosphorus levels are found in nephritis and prolonged excessive vomiting. Occasionally high levels are found in acute yellow atrophy of the liver and myelogenous leukemia

Phosphatase.—Phosphatase is an enzyme found in high concentration in the cells of bone and in small amounts in the kidneys and striated muscles The phosphatase blood level is increased in Paget's disease, hyperparathyroidism, osteoporosis, and active rickets in which there is abnormal activity of the bone cells. The blood level may be elevated in obstructive jaundice and kidney disease. The normal plasma level ranges from 1.5 to 4.5 units per 100 cc in adults and 4.0 to 11.0 units in children.

Bile and Bile Pigments.—Normal blood contains a small amount of the bile pigment bilirubin (0.1 to 0.5 mg. per cent). It is this pigment that gives the serum its yellow color. Bilirubin is formed from the physiological destruction of the red blood cells. The bilirubin (hemobilirubin) passes from the circulating blood to the liver, where it is modified by the liver cells; then it passes into the gall bladder, where it is concentrated and excreted into the intestinal tract. If disease affects any part of this cycle so as to cause an increase in the bile pigment in the blood, bile will escape into the tissues The tissues (skin,

its salt, providing the degree of change is not too great. Normal values for the carbon dioxide combining power range from 55 to 80 volumes per cent. Values between 55 and 40 volumes per cent indicate a mild acidosis. Values of 30 volumes per cent or lower indicate severe acidosis. If acidosis is untreated, the carbon dioxide combining power of the blood progressively decreases and may reach very low levels.

Alkalosis is the accumulation of alkali in the blood. Excess of alkali in the blood may be due to loss of chloride as occurs in severe vomiting of high intestinal obstruction or overdosage of sodium carbonate, as frequently happens in patients with peptic ulcers. The degree of alkalosis is also determined by the van Slyke and Cullen method. In alkalosis the carbon dioxide combining power is elevated and may be 90 volumes per cent or more.

Miscellaneous Tests.—Here shall be considered tests that are done only under certain conditions. Test for alcohol: The normal values vary considerably, as do also the values obtained after the taking of alcohol. The test should, therefore, be interpreted only by a person who has been well trained both in the technique of the test and in its application. In general, individuals with a blood alcohol level of 0.15 per cent or more are considered intoxicated.

Blood iodine determinations are occasionally done in thyroid disease. Normal blood contains minute amounts of iodine (1.5 to 12.8μg). Iodine blood levels are helpful in diagnosing border line cases of hyperthyroidism. In hyperthyroidism the iodine blood level may vary between 2 and 155 μg per cent, the average being 21 μg per cent. The blood iodine level may be increased in gall bladder disease, leukemia, infections that produce fever, and after the administration of iodine as therapy for thyroid disease

In diseases associated with deficiency in vitamins (avitaminosis), it is sometimes important to know the vitamin content of the blood. For example, vitamin C (cevitamic acid) is decreased in scurvy, tuberculosis, and other chronic illnesses. The blood of normal individuals contains 0.8 mg. of vitamin C per 100 cc of blood.

Blood Concentration of Drugs Used in Chemical Therapy.—With the introduction of such new drugs as the sulfonamides,

normal osmotic pressure and balance of the various substances in the body which influence the amount of water contained in the body tissues and circulating blood. Normal blood plasma contains 570 to 600 mg. per cent of chloride as sodium chloride (NaCl). Whole blood contains less (450 to 500) because the red blood cells contain a small amount.

An increase in the blood chloride is found in acute nephritis and nephrosis. The edema that results is due mainly to the loss of protein and secondarily to the retention of sodium chloride

Low blood chloride levels are more common and important and are found in many pathological conditions Low levels are found in excessive vomiting as occurs in intestinal obstruction and pernicious vomiting of pregnancy because large amounts of salt are lost in the vomitus. Extensive burns produce low chloride levels because excessive salt is lost through the exudate that appears over the burned area. Excessive sweating without a normal intake of salt results in depletion of body salt and a condition called heat exhaustion or stokers' cramps. Abnormally low chloride levels are also found in pneumonia, prolonged diarrhea, and severe diabetic acidosis.

Acidosis and Alkalosis.—The *acid-base* balance of the body fluids is one of the most constant and stable mechanisms in the body. The equilibrium of the acids and the bases in the body fluids is maintained by the exchange of gases (oxygen and carbon dioxide) in the lungs and the excretions of the different body salts by the kidneys The hydrogen ion concentration (pH) of the blood in normal individuals ranges between 7.35 and 7.45, with an average of 7.40

The chief factors in maintaining the normal acid-base balance in the body are the dissolved buffers (carbonates, phosphates, carbonic acids, and proteins), which are present as weak acids, and their potassium and sodium salts. A buffer is a substance which turns alkaline when the blood becomes acid and turns acid when the blood becomes alkaline, thus attempting to maintain the blood near a constant hydrogen ion concentration. Sodium is the most important ion in the fluid that surrounds the body cells (extracellular fluid), while potassium is the most important ion in the fluid inside the body cells (intracellular fluid). The main function of the buffers is to prevent any change in the pH of the body fluids. The action of the buffers maintains a constant ratio between the weak acid and

CHAPTER 20

LABORATORY DIAGNOSIS (Continued)

TRANSUDATES AND EXUDATES

Under normal conditions the pleural, peritoneal, and joint (synovial) cavities contain a very small amount of fluid The pericardial cavity normally contains a few cubic centimeters of clear straw-colored fluid. When disease occurs in the body, in these cavities, or adjacent to them, the cavities may become filled with fluid. The fluid that forms is of two types: transudate and exudate. It is obtained by inserting a trocar or needle into the cavity and withdrawing the liquid.

In nephritis, heart failure, and cirrhosis of the liver, circulation of the blood in the small capillaries is impaired. Stasis and an increased pressure which results forces the fluid portion of the blood through the capillary wall into the serous cavity and subcutaneous tissues This fluid is noninflammatory in origin and is called a transudate It is usually clear or light yellow in color It has a specific gravity of 1 017 or less and contains a few cells (lymphocytes) but no bacteria. Transudates contain 2.5 to 3.0 grams of protein per 100 cc of fluid. It does not coagulate Microscopic examination may show a few red blood cells, but these come from the trocar used in obtaining the fluid

An exudate results from an inflammatory condition in the serous cavities Exudates vary greatly in their characteristics, depending upon the cause. They may be serous, serofibrinous, purulent, hemorrhagic, or chylous Serous, serofibrinous, and purulent exudates are most commonly seen in the various stages of inflammation due to any of the pyogenic bacteria They may be bloody if due to cancer, trauma, tuberculosis, or hemorrhagic diseases Chylous exudate is milky white in appearance and results from a blocking of the lymphatics as occurs in such diseases as filariasis, cancer, and tuberculosis of

penicillin, and streptomycin, it has become necessary to devise methods of determining their concentrations in the blood and other body fluids. For these drugs to be effective, they must be present in the blood in adequate concentrations. Determination of the blood level assures adequate concentration and prevents overdosage.

1. Sulfonamides: There are various types of sulfa drugs, and each has a different blood concentration at which it is most effective. The blood level for sulfanilamide should range between 8 and 12 mg. per 100 cc; for sulfadiazine, between 10 and 20 mg. per 100 cc; for sulfathiazole, between 6 and 10 mg. per 100 cc; for sulfapyridine, between 7 and 10 mg. per 100 cc; for sulfamerazine, between 8 and 10 mg. per 100 cc.

2. Antibiotics: Determining the concentration of penicillin and streptomycin is a long and difficult procedure. It is important to know whether the concentration of the antibiotics in the blood, plasma, serum, urine, and exudates is high enough to prevent the growth of the bacteria in the body. The concentration of penicillin and streptomycin is determined by titrating their bacteristatic power on suitable test organisms or, when possible, against the organism which has been isolated from the patient and which is known to cause the disease. For penicillin, the *Streptococcus pyogenes* is used, and for streptomycin, staphylococcus is used.

3 Patients receiving potassium thiocyanate (KSCN) for treatment of high blood pressure should have KSCN blood serum levels checked weekly because the therapeutic effective dose is frequently close to toxic amounts.

Physical Characteristics.—

1. **Volume:** This is the amount of sputum brought up by the patient over a twenty-four hour period. Abnormally large quantities of sputum occur with pulmonary edema due to heart failure, pulmonary hemorrhage and gangrene, far-advanced tuberculosis, and bronchiectasis. A liver abscess may perforate the diaphragm and invade the lung, and the patient may suddenly cough up large quantities of foul-smelling sputum.

2. **Appearance:** The phlegm so commonly brought up by heavy cigarette smokers is usually clear mucus containing suspended curdlike particles. The color is normally clear or white, or it may have a yellowish tinge. If the sputum contains much mucus and pus, it is yellow or green in color. The sputum may vary from being a liquid, as occurs in perforating lesions of the lungs from liver abscess, to a very thick tenacious sputum, as seen in pneumonia. A frothy, pink-tinged, thin sputum is seen in pulmonary edema due to congestive heart failure.

3. **Odor:** Fresh sputum does not have an odor unless bacterial decomposition has taken place. Diseases such as lung abscess, bronchiectasis, gangrene, and tuberculosis with cavitation produce a foul-smelling sputum

4. **Color:** The color of sputum depends upon the substances it contains. Mucoid sputum is clear and colorless. Yellow or yellow-green sputum is seen in pneumonia, bronchiectasis, and sinusitis A rusty sputum is seen in the various pneumonias and pulmonary infarct. Green sputum may be seen in pneumonia and jaundice due to staining from the bile pigments. Bright red sputum or bloody sputum is found in lung cancer, pulmonary tuberculosis, heart disease, lung abscess, and bronchiectasis

Various particles found in the sputum may be of diagnostic importance, for example, the small, yellow granules associated with mycotic infections (actinomycosis), and the small yellow or gray caseous, foul-smelling particles (Dittrich's plugs) found in bronchiectasis.

Microscopic Examination.—The importance of this examination is the identification of the solid particles, crystals, bacteria, and red and white blood cells. Since it is almost

the lymph nodes. Exudates coagulate, contain many cells and bacteria, and have over 3 per cent albumin.

Exudates contain a large number of leukocytes. These are counted in the same manner as are blood counts. The smear is prepared in the same manner as the differential smear. Lymphocytes and eosinophiles are more common in pleural exudates due to tuberculosis, while neutrophiles are found as a result of pyogenic infection. Pyogenic infections of the pleural cavity produce a thick yellow or green fluid. If the fluid becomes thick (pus), it is called empyema. In cancer of the serous surfaces, a bloody or cloudy exudate may be found containing clumps of cancer cells showing abnormal growth changes (mitotic figures).

When fluid collects in the pleural cavity from heart or kidney disease, it is called hydrothorax or pleural effusion. Fluid collecting in the peritoneal cavity is called peritoneal effusion, and fluid in the pericardial sac is called pericardial effusion.

Synovial fluid found in the joints may be an exudate or transudate, and it has the same characteristics as described for the fluids in the body cavities.

Exudates are frequently seen in infections of the mucous membranes of the eyes, nose, mouth and throat, skin, ears, and genitourinary tract.

SPUTUM

Sputum is matter expectorated from the air passages. In normal healthy persons, sputum is either absent or at most present in very small amounts and is usually referred to as phlegm. Sputum produced in excessive amounts indicates pathology of the respiratory system (larynx, bronchi, or alveoli of the lungs).

Specimens are collected in paper cartons, which can be burned afterward, or wide open-mouth bottles fitted with stoppers Preservatives are not added as they interfere with the bacteria, and then the specimen is not suitable for cultures or animal inoculation

To collect a single specimen, the patient should first rinse his mouth with water and then cough deeply and expectorate into a sterile container. Infants and young children and some adults habitually swallow their sputum. In these, sputum must be obtained through a stomach tube.

sputum may contain streaks of blood. The sputum contains bacteria, pus cells, and desquamated epithelium. In chronic bronchitis the sputum is abundant, thick, yellow, and more mucoid than purulent. It also contains bacteria, pus cells, epithelial cells, and, occasionally, bronchial casts.

In bronchiectasis the sputum is abundant and often fetid. It is gray-green in color and frequently tinged with blood. On standing, it will separate into three layers; the top layer is frothy, the middle layer is cloudy and green, and the bottom layer contains a sediment of bacteria, pus, and elastic fibers.

In the early stages of tuberculosis the sputum may be scanty or profuse, mucoid or mucopurulent, with occasional flecks of blood and yellow particles. As the disease progresses and cavitation develops, the volume of sputum increases and contains caseous material and blood and becomes yellow-green in color.

In lung abscess the sputum is abundant, foul smelling, and yellow or green in color and contains numerous pus cells, a great variety of bacteria, elastic fibers, and red blood cells

When gangrene of the lung tissue develops, the volume of sputum increases, has a foul odor, and is green or brown in color. On standing, it will separate into three layers, the top layer is thick and frothy, the middle layer is more liquid and thin, and the bottom layer is brown-green in color and contains fragments of lung tissue.

In lobar pneumonia the sputum is usually rusty or blood-tinged and of varying amounts. The sputum of the other pneumonias may have the same characteristics Most pneumonias produce sputum that is mucopurulent, thick, and yellow or green in color. It contains numerous bacteria, with the causative organism predominating, pus cells, and red blood cells. The majority of the pus cells are neutrophiles, since most pneumonias are due to pyogenic bacteria

Following an attack of bronchial asthma, the volume of sputum increases, is mucoid, gray in color, and contains numerous eosinophiles, Curschmann's spirals, and Charcot-Leyden crystals.

In the early stages of cancer the quantity of sputum produced may be scanty and mucoid, occasionally containing

impossible to examine the entire specimen of sputum, it is essential to select a portion that appears most likely to yield significant findings. The particles to be examined are removed and placed on a clean glass slide. This is placed under the microscope and studied before and after staining. Cheesy or caseous particles should be gently smashed or pressed out flat so as to make a thin smear. For general study, methylene blue and Wright's stain are used. Gram's stain is used to study the various bacteria, and the acid-fast stain is used for tubercle bacilli

Elastic fibers in a fresh specimen indicate marked destruction of lung tissue (gangrene, far-advanced tuberculosis). They appear as slender or curled refractile bundles of tissue. The elastic fibers come from the walls of the bronchi and alveoli. Spiral masses of delicate fibrils (Curschmann's spirals) are characteristic of bronchial asthma. Epithelial cells appear as large oval or angular bodies containing a small nucleus. Large mononuclear cells, "heart failure cells" capable of engulfing bacteria (phagocytosis), and foreign material such as carbon particles contain brown granules, and they give the sputum a brown color. These cells are found in the sputum of coal miners and truck drivers and individuals suffering from congestion of the lungs due to heart disease. Pus cells (neutrophiles) are difficult to make out, as they are indistinct due to degeneration They are numerous in pyogenic infections of the lungs Eosinophiles are abundant in bronchial asthma The red blood cells retain their characteristics far better than do the white cells and are present in any lung lesion that causes bleeding or extravasation of red cells into the alveoli and bronchi.

Colorless pointed hexagon crystals (Charcot-Leyden crystals) are associated with bronchial asthma. Fungi in the sputum may appear as sulfur granules (actinomyces-ray fungus), and, when crushed, reveal a characteristic radiating pattern of spicules. Blastomyces appear as round or oval cells with small budlike protrusions having a double contour. Monilia appear as scattered yeastlike budding cells

Sputum in Various Diseases.—In the early stages of acute bronchitis the sputum is clear and scanty, but later it increases in volume, becoming mucopurulent and green or yellow in color. Following a severe episode

in a drop in pressure which may be fatal. A moderate increase in pressure due to brain tumor, hemorrhage, or abscess is not a contraindication.

Although the lumbar puncture is a simple procedure it requires the aid of an assistant to be performed properly. Since the assistant in the majority of cases is the nurse, it is necessary that she become well acquainted with the technique and instruments used. The lumbar puncture may be performed with the patient sitting or lying down. Since most patients have a great fear of having a needle inserted into their back or spine, the nurse or the doctor must explain to the patient what the procedure entails and what he should do to help shorten the time required to make the puncture The patient is placed on his side with the head bent and the knees drawn up under the chin. This position bends the back and separates the spinous processes of the vertebrae. In the sitting position the patient sits on a stool, bending forward as much as possible. The skin over the lumbar vertebrae is cleansed with iodine and alcohol and then draped with sterile towels The interspaces below the second or third lumbar spines are located, and the skin over either space is infiltrated with 1 per cent novocain. After waiting a few minutes, novocain is injected into the subcutaneous tissue The puncture is done with a special type of long needle containing a stylet. After the needle has been inserted into the subarachnoid space, the stylet is removed and fluid should flow at once Normally the fluid drips from the needle, but if the pressure is increased, it flows rapidly or spurts out

The normal spinal fluid pressure is 100 to 160 mm. of water. It may occasionally reach 200 mm. Sometimes it is expressed in millimeters of mercury by dividing the water pressure by 13, the specific gravity of mercury. It is increased in meningitis (pyogenic and tuberculous), poliomyelitis, encephalitis, brain tumor and brain abscess, and cerebral and subarachnoid hemorrhage

Normally the spinal fluid circulates freely between the ventricles of the brain and the spinal canal, and pressure on the jugular vein normally produces a rise in the spinal fluid. This rise is impaired or absent if the flow between the ventricles and the spinal canal is blocked by some pathological lesion.

small flecks of blood. As the disease progresses, the volume of sputum increases and becomes bloody, and occasionally cancer cells can be found.

CEREBROSPINAL FLUID

The cerebrospinal fluid is a clear waterlike liquid found in the ventricles and subarachnoid spaces of the brain and in the spinal cord. It is related to the nervous system as the circulating blood is to the heart and other systems of the body. The fluid is formed by small blood vessels (choroid plexus) located in the lateral ventricles. After the fluid leaves the fourth ventricle, it passes through small openings (foramina) into the subarachnoid space that surrounds the brain and spinal cord. For practical purposes the skull and vertebral column may be considered a rigid cage in which the spinal fluid circulates. With this understanding it is easy to see why an increase in volume of spinal fluid produces an increase in pressure which will cause the ventricles to dilate (hydrocephalus). In adults the skull cannot expand, so the ventricles are the only spaces that can dilate, while in infants in whom the bones of the skull have not fused, the soft spots on the head (fontanels) will expand and bulge (macrocephalus). The normal volume of spinal fluid is thought to be 150 cc. Under abnormal conditions the total volume of fluid is increased. The main function of the fluid is mechanical protection of the brain and spinal cord.

Examination of the cerebrospinal fluid is important in the diagnosis of disease of the central nervous system. The fluid is obtained by inserting a needle into the subarachnoid space of the spinal cord, the cisterna magna, or ventricles The lumbar puncture is by far the most common method, while the latter two are used for special therapeutic or diagnostic reasons.

The cerebrospinal fluid is removed not only for examination, but also to relieve abnormally high pressure, to remove blood and exudates that may form, to administer drugs, air, dyes, and anesthetics, and to help locate tumors of the central nervous system In most cases a lumbar puncture is without danger, but in cases in which the intracranial pressure is greatly increased, the removal of

Microscopic Examination.—This examination consists of a study of the number and kind of cells and bacteria present.

1. **Cell Count:** The cells in the spinal fluid are counted in a blood-counting chamber in the same manner that the red and white blood cells in the blood are counted. Normal spinal fluid contains from 0 to 5 white cells (lymphocytes) per cubic centimeter of fluid and no red cells. When more than 10 lymphocytes are found in the spinal fluid, it is a definite sign of some underlying pathology. An increase in the cell count with the lymphocytes predominating (60 to 75 per cent) is suggestive of tuberculous meningitis or syphilis of the nervous system. In acute meningitis due to pyogenic bacteria, the total cell count may vary between 100 and several thousand cells, with the neutrophiles predominating Elevated counts are also found in encephalitis, poliomyelitis, brain or spinal cord tumors, and cerebral hemorrhage.

The smear for a differential count is prepared in the same manner as a blood smear and stained with methylene blue and Wright's stain.

2. **Bacteriological Study:** To obtain material for a bacterial examination, the spinal fluid is centrifuged, the sediment removed, and a smear made. This is stained with Gram's stain for study of the majority of the bacteria and with Z-N stain for tubercle bacilli Bacteria are found in the smears and cultures in the majority of cases of meningitis due to streptococcus In tuberculous and meningococcic meningitis, the bacteria are more difficult to find In tuberculous meningitis a delicate membrane of coagulum forms on the surface of the spinal fluid if it is allowed to stand for twenty-four hours This is removed, smeared on a glass slide, and stained by the acid-fast method. If tubercle bacilli are not found, guinea pig inoculations must be done The organism of meningococcic meningitis is an intracellular diplococcus which cannot be differentiated from the gonococcus on stained smears To do this, more detailed laboratory study is required

Chemical Examination.—The routine chemical tests done on the spinal fluid are total protein, globulin, sugar, and chloride. The nonprotein nitrogen is not determined as it has the same level as that of the blood. Calcium determinations are not

The spinal fluid pressure can be measured directly by a calibrated manometer which is attached to the spinal puncture needle. Normally the manometer will register pulsations of 1 to 4 mm. Readings are obtained when digital pressure is applied to the jugular veins (the Queckenstedt test).

After the pressure determinations have been completed the cerebral spinal fluid is collected in three sterile test tubes labeled 1, 2, and 3. The first tube receives the first few drops of fluid. This fluid may be slightly bloody due to bleeding from small blood vessels cut by the needle when it is inserted. The second and third tubes receive 4 cc of fluid. The third tube usually contains a small amount of potassium oxalate to keep the fluid from clotting. The three tubes are immediately taken to the laboratory for examination. One tube is placed in the incubator for bacterial culture study, and the other two are placed in the refrigerator. The spinal fluid is examined for physical characteristics, red and white blood cells, bacteria, and chemical and serological contents.

Upon completion of the spinal puncture the patient is kept flat in bed for twenty-four hours to prevent headache, which probably is due to lowered spinal fluid pressure which results when fluid is removed for examination and from seepage of fluid into the subcutaneous tissue.

Physical Characteristics.—Normal cerebrospinal fluid is clear and resembles water It may be cloudy due to the presence of white or red blood cells or bacteria. Cloudiness is common in meningitis due to pyogenic bacteria (tuberculosis) In diseases that *injure* the meninges (meningitis), there may be an increase in protein production, particularly fibrinogen, and on standing, the spinal fluid will clot. Spinal fluid that clots is always pathological Clot formation is common in purulent and tuberculous meningitis It is less common in anterior poliomyelitis and encephalitis. Purulent fluid may be yellow, green, or white, depending upon the bacteria present. Clear or slightly cloudy yellow fluid (xanthochromia) is usually due to red blood cell disintegration resulting from cerebral hemorrhage, brain or spinal cord tumor, and acute inflammation of the meninges.

Normal spinal fluid has a specific gravity of 1 003 to 1.008. The reaction is alkaline

Serological Tests.—The most accurate method of diagnosing syphilis of the central nervous system is by serological examination of the spinal fluid. The complement fixation test (Wassermann) and the precipitation tests of Kahn and Kline are easy to perform, but they do not indicate the type of neurosyphilis which is present. The colloidal test, although no more sensitive than the others, is helpful in differentiating between the paretic and tabetic type of neurosyphilis.

The original colloidal gold test was introduced by Lange in 1912. Since then, numerous tests with the same principle have been devised by other workers, and these tests are just as sensitive as Lange's method. The following modification is commonly used.

Orange-red	0
Red-blue	1
Lilac or violet	2
Blue	3
Pale blue	4
Colorless	5

Since normal fluid shows no change in color, it is reported as 0000000000. Abnormal spinal fluids may show three different types of color changes which will give the following readings:

Paretic type	5555543210—also called first zone type
Tabetic type	0001232100—also called second zone type
Meningitic type	0001245321—also called third zone type

The colloidal gold test is also very helpful in following the response of syphilis to treatment. The first zone reaction is not specific for paresis, as it may occur in other types of syphilis and multiple sclerosis. The second or midzone reaction may be seen not only in the luetic type of syphilis, but also in brain tumors, cerebral-vascular lesions, and virus diseases. The third zone reaction is seen most commonly in purulent meningitis.

done since the calcium level in the spinal fluid will be i creased if the spinal fluid protein level is increased.

1. **Total Protein:** The total protein in normal spinal flu ranges between 15 and 40 mg. per 100 cc. The average 25 mg. per 100 cc. In diseases of the central nervous syste the meninges become inflamed and their permeability serum proteins is decreased, allowing them to pass from th blood into the spinal fluid. In almost all diseases of the brai and spinal cord there is an increase in the total proteins, an the degree of increase depends upon the severity of the infec tion or lesion if a tumor is present. If the spinal fluid contain blood or bacteria, the protein level will be elevated.

In normal cerebrospinal fluid, albumin makes up most o the protein, but in disease it is the globulin and fibrinoge protein fractions that increase the most.

Globulin is demonstrated by the Pandy test. One drop o spinal fluid is added to 1 cc of phenol or carbolic acid. I globulin is present, a white cloud appears. Normal spina luid may produce a very faint turbidity.

2. **Sugar:** Normal spinal fluid contains 50 to 80 mg. of lucose per 100 cc, or about one-half the concentration nor nally present in the blood. The amount of sugar in the spinal uid depends upon the blood sugar level; if the blood sugar s elevated, the spinal fluid sugar level will be elevated also. n bacterial infections of the brain or spinal cord the sugar s reduced and may reach low values such as 50 or 25 mg his is due to the action of the bacteria on the glucose which ey break down and use for their own metabolism. Virus nfections such as poliomyelitis and encephalitis show no hange in the spinal fluid sugar. In tuberculous meningitis e sugar level may be normal or slightly lower than normal.

3. **Chlorides:** In normal spinal fluid, the sodium chloride vel ranges between 720 and 750 mg. per 100 cc but varies ith the chloride content of the serum. In acute meningitis e chloride concentration may be normal or slightly lower an normal. In tuberculous meningitis the chloride concen- ation is usually very low, often less than 550 mg. per 100 . Infections such as encephalitis, poliomyelitis, and neuro- philis produce no change in the chloride concentration of e spinal fluid.

tients are sensitive and become excited when the tip of the tube touches the pharynx, causing them to gag and retch. This can be prevented if the nurse or doctor explains and instructs the patient in the technique and what to expect. Also if the gastric tube is chilled in ice water, it is easier to swallow. The tip of the tube is placed in the mouth on the back of the tongue, and the patient is instructed to swallow and at the same time gently to push the tube inward. An occasional deep breath sometimes makes it easier to swallow the tube. The tip of the tube has reached the stomach when the first ring marked on the tube (50 cm.) reaches the teeth. Passage of the tube through the nose may be used if the nasal passages are open and do not contain a defect. The tip of the tube is lubricated with a few drops of glycerine and then placed in the nose and slowly pushed backward until the patient feels the tube in the pharynx. Then, the patient swallows and pushes the tube down until the first colored ring marked on the tube reaches the nose. This marker indicates that the tip of the tube has reached the stomach. When the tube reaches the stomach, the syringe is attached to the end of the gastric tube and the fasting contents removed and placed in a specimen bottle

After the tube has been passed, it may become clogged with mucus. Injection of air will remove the mucus from the lumen. To make sure that all the gastric contents are removed at each aspiration, the tube should be raised and lowered several times while suction is applied with the syringe.

In most cases, the gastric tube is passed without danger. However, conditions such as cancer and stenosis of the esophagus, recent hemorrhage from the stomach, and esophageal varices are contraindications to passage of the tube.

Since some patients become nauseated and vomit during the passage of the tube, the patient should be covered with a rubber apron or sheet for protection After the fasting sample has been removed and the test meal given, the gastric tube should be fastened to the side of the patient's face with adhesive tape. This keeps the tube in place and prevents it from slipping out This also makes the patient more comfortable, and the tube can be kept in the stomach for several hours if necessary.

CHAPTER 21

LABORATORY DIAGNOSIS (Continued)

ANALYSIS OF THE STOMACH AND DUODENAL CONTENTS

The epithelium that lines the stomach contains special types of cells that secrete various digestive enzymes and hydrochloric acid. The protein-splitting enzyme, pepsin, becomes active after the ingested food has been acted upon by hydrochloric acid. The milk-curdling enzyme, rennin, coagulates milk. The fat-splitting enzyme, lipase, is very weak in its action and is of little importance. The hydrochloric acid helps in the absorption of iron and destroys the bacteria ingested with food. The hydrochloric acid values of the gastric juice are used as indicators of the secretory activity of the stomach. Examination of the gastric juice is done on the fasting stomach and again after ingestion of a test meal.

In normal persons an empty stomach does not secrete gastric juice unless stimulated by a psychic response from the thought or sight of food. Normally the stomach is stimulated to secrete gastric juice by the presence of food in the stomach. Therefore, it is necessary to give the patient some sort of stimulation (food) after the fasting specimen has been removed There are numerous types of test meals. The three most common test meals used are the Ewald meal, alcohol meal, and histamine.

Obtaining the Gastric Contents (Gastric Analysis).—The gastric secretions to be used for examination are obtained by passing a special rubber tube (Levin tube) through the nose or mouth into the stomach after which a sample of the stomach contents is aspirated by a 50 cc glass syringe. Passage of the tube is usually without difficulty; however, some pa-

the obstruction is below the ampulla of Vater. To make it easier to recognize food particles, a handful of raisins should be eaten the night before with the evening meal.

Gross Appearance: The color of the stomach contents varies with the test meal used and the presence of bile and blood. With the Ewald meal, normal gastric juice is gray, while with alcohol or histamine it is clear or tinged with yellow. Normal gastric juice does not contain bile unless there was extreme gagging and retching during the passage of the tube, which causes some regurgitation of bile into the stomach. Bile gives the gastric juice a faint yellow or green color. Gross blood in the gastric juice is important if trauma to the stomach mucosa by the stomach tube can be ruled out. *Small quantities or flecks of bright red blood are usually due* to trauma of the mucous membrane by the tube Gross blood is usually very dark (brownish) or coffee-ground color in appearance. If the fasting sample is of this color, the gastric tube should be removed at once. Gross blood usually indicates stomach ulcer, cancer of the stomach, or peptic ulcer.

Mucus in the stomach contents is usually due to saliva swallowed during the passage of the tube. Mucus appears as stringy white masses which float on the surface of the gastric juice.

Normal gastric juice has a penetrating strong odor that is easy *to recognize. Absence of this odor suggests the absence* of hydrochloric acid (achlorhydria). It is important to note if the gastric juice has a fecal odor. A fecal odor may indicate intestinal obstruction or an ulcerating cancer of the stomach.

Pus in the gastric juice usually comes from sputum that has been swallowed. This is particularly true in patients who are ill with tuberculosis and in children It is a common practice routinely to examine the gastric juice of patients ill with tuberculosis if the tubercle bacilli cannot be found in the sputum obtained in the usual manner They may be obtained in swallowed sputum.

Microscopic Examination: A small portion of the gastric juice is removed with a wire loop, placed on a glass slide, then covered with a thin glass cover slip, and studied under the microscope.

After this has been done, the patient is given a test meal which consists of 50 cc of 7 per cent ethyl alcohol or a slice of dry toast and a cup of tea (Ewald meal). The alcohol is usually given by injection through the tube. The toast and tea are taken by the patient. After the test meal has been given, gastric juice samples are removed with the syringe at the end of fifteen, thirty, and sixty minutes. Each sample is placed in a separate specimen bottle. The samples are tested for the amount of acid contained in each and a "curve" plotted.

In the histamine test, histamine phosphate, 20 mg, is injected hypodermically. It is used in cases where hydrochloric acid is absent from the gastric secretions when the other test meals are used. For example, it is of great diagnostic importance in determining a true absence of hydrochloric acid in suspected cases of pernicious anemia.

The combination of one of the other test meals and histamine is common. For example, after the Ewald test meal has been given and the samples removed, the tube is left in place. If the specimens fail to show the presence of hydrochloric acid, histamine is injected and the test continued for several more hours.

Examination of the Stomach Contents.—All the specimens obtained during the gastric analysis are sent to the laboratory in properly labeled specimen bottles. They are measured for volume and studied grossly for their color, food particles, mucus, odor, pus, and blood. A microscopic examination is done to look for pus cells, red cells, starch granules, bacteria, and food particles. A chemical analysis is made to determine the presence and concentration of hydrochloric and lactic acid.

The normal fasting specimen usually contains not more than 50 cc of liquid mucoid material. The volume is variable, but if it exceeds 100 to 120 cc. it is considered pathological. A marked increase in the flow of gastric juice without food particles indicates gastric hypersecretion. If food particles are found after the patient has been fasting for twelve hours, it indicates a delay in the stomach emptying or obstruction of the pylorus. Normally the stomach empties in five to seven hours. If the fasting specimen contains both food and bile,

The fasting gastric juice of normal individuals shows a free hydrochloric acid range from 5 to 25 units, with a total acid range from 10 to 35 units. After ingestion of a test meal the glands of the gastric mucosa are stimulated and the production of hydrochloric acid is increased. In most normal stomachs the peak of free acid production (25 to 50 units) is reached by the end of the first hour. The total acid will range between 35 and 65 units. With the histamine test meal the free hydrochloric acid will range from 40 to 140 units by the end of the first half hour.

An increased concentration of free hydrochloric acid (60 units or more) is called hyperchlorhydria. It is commonly associated with duodenal and gastric ulcers, early gastritis, and emotional upset. It may be found in appendicitis and gall bladder disease.

A decrease in the concentration of free hydrochloric acid is called hypochlorhydria. The values are below 20 units This condition is found in cancer of the stomach, hypothyroidism, old age, fatigue, chronic infections, and alcoholic gastritis. Occasionally a decrease is found in diseases producing fever (pneumonia) and in individuals depressed by some nervous state.

Absence of free hydrochloric acid is called achlorhydria. It is frequently associated with the same disorders that produce hypochlorhydria. Achlorhydria is found in pernicious anemia, pellagra, sprue, and advanced cancer of the stomach. Its greatest value is in the diagnosis of pernicious anemia. Free hydrochloric acid is always absent from the gastric juice even after histamine injection. If free acid is present, the diagnosis of pernicious anemia must be questioned.

Lactic acid is found in the gastric juice when the hydrochloric acid content is low and there is gastric stasis. Lactic acid is commonly found in cancer of the stomach and in lesions that obstruct the pylorus.

Pepsin and rennin are so frequently associated with hydrochloric acid in the gastric juice that their absence usually indicates organic disease of the stomach

Vomitus—Important information may be obtained from careful examination of the vomitus Too often this material is thrown out before it can be examined Vomiting is frequent-

A small number of red blood cells are normally found due to trauma caused by the gastric tube. If found in large numbers they have the same pathological significance as gross blood.

Generally white blood cells are not significant. They are usually swallowed with mucus from the nasal and oral passages. However, they are significant if stained yellow with bile and associated with tall columnar shaped cells from the duodenum or gastric mucosa. This indicates inflammation

Swallowed mucus is the most common constituent of gastric juice. It is easily differentiated from stomach mucus by its gross appearance; the latter is more flocculent if the gastric juice is acid. Mucus from the gall bladder is stained yellow.

Bacteria usually do not live in the gastric juice. Their presence in excessive numbers is significant. The bacteria in the gastric juice increase as the acidity of the stomach contents decreases. Streptococci in the stomach contents do not indicate infection of the stomach wall (gastritis). They usually come from mucus from the nasal passages which has been swallowed. A particular organism, the Boas-Oppler bacillus, is commonly found in individuals suffering from cancer of the stomach and from decreased acid production. Parasites are rarely found in the gastric juice. When found, they are usually due to a backflow of duodenal contents.

Crystals are commonly found in the gastric juice. They usually come from food and are difficult to identify. However, the crystals of cholesterol and calcium bilirubinate are usually associated with gallstones

Microscopic examination will differentiate food particles from epithelial cells, mucus, and pus. A few particles in the fasting specimen are common. Their presence in large numbers may indicate a delay in the emptying of the stomach.

Chemical Examination: This includes a study for the presence of hydrochloric acid, lactic acid, and the enzymes pepsin and rennin.

Hydrochloric acid is present in the gastric juice in two forms: (1) a free hydrochloric acid and (2) in combination with protein ("combined hydrochloric acid"). The total acid content of the stomach is determined by adding the free and combined hydrochloric acid.

black in color, it may indicate that the function of the gall bladder is impaired and the bile in the gall bladder is over-concentrated and stagnant due to stasis.

Normal duodenal fluid is clear or slightly yellow and thick like syrup It is alkaline in reaction. It usually contains a small amount of urobilin.

In pathological conditions of the gall bladder and pylorus the duodenal contents may contain an abnormal amount of bile, blood, pus, and bacteria and may be mixed with gastric juice.

ly due to obstruction of the bowel. Intestinal obstruction may be due to mechanical obstruction, such as scar tissue bands (adhesions), which cause a stricture, strangulation, twisting of the bowel (volvulus) benign or malignant tumors originating from the intestinal wall, folding of one segment of the bowel within another (intussusception), or agents outside the intestinal tract such as tumors, or abscesses that occlude the lumen by pressure.

Vomitus ejected from a stomach that is secreting the normal amount of hydrochloric acid has a characteristic sharp odor. Vomitus coming from a dilated esophagus due to spasm of the upper end (cardia) of the stomach does not have the pungent odor of normal gastric juice. Vomitus with a fecal odor is characteristic of low intestinal obstruction.

In most cases vomitus containing food particles which were ingested six to eight hours previously is due to some obstruction near the outlet of the stomach. A large amount of food that is bile stained indicates an obstruction below the pylorus.

Vomitus consisting mostly of pure gastric juice is usually due to active duodenal ulcer with hypersecretion and spasm of the pylorus.

Analysis of the Duodenal Contents.—The duodenal contents are obtained by means of a rubber tube with a perforated metal tip (Rehfuss tube) introduced in the same manner as the tube for a gastric analysis. However, it is necessary that the patient lie on the right side with the hips slightly elevated to allow the tip of the tube to be pushed into the opening of the pylorus by the force of gravity and the peristaltic movements of the stomach. This usually requires thirty to forty-five minutes. When the tube reaches the pylorus, the aspirated fluid changes from acid to alkaline To test for the flow of bile from the gall bladder, extra stimulation is required. This is obtained by injecting through the tube 50 cc of 25 per cent magnesium sulfate after the tube has reached the pylorus. This causes the sphincter of Oddi to relax, allowing the bile of the gall bladder to flow. The intestinal contents are then aspirated and examined for pancreatic ferments and urobilin. Following the injection of magnesium sulfate, bile usually appears in the aspirated fluid within five to thirty minutes. If the fluids are closely watched, they will be seen to change color. If the bile is dark green to

or peristalsis rapid, the stools become watery (diarrhea). Normal stools are cylindrical in shape, with a smooth surface, firm to moderately soft in consistency, and well formed. Very soft stools may be normal for some persons who habitually have two or three stools a day. Hard, small balls or pellets indicate a spastic colon. Severe spasm of the anus, cancer of the rectum, and stricture of the rectum (syphilis, cancer) are associated with ribbonlike or pencil-shaped stools. Soft, watery or liquid stools may follow the use of laxatives or be associated with diarrhea from any cause. Watery stools containing very little formed feces are associated with food poisoning (bacterial), cholera, and acute gastrointestinal upsets. Severe diarrhea accompanied by streaks of red blood in the stool is found in amebic dysentery, cholera, and parasitic infestations of the intestinal tract.

The color of the normal stool is due to the pigment stercobilin. It is formed from bilirubin. Foods influence the color of stools A milk diet results in very light yellow-brown stools; a diet consisting mostly of meat produces dark brown feces; spinach gives the feces a greenish color; carrots and beets produce a reddish stool. Clay-colored stools appear when there is a deficiency of bile in the feces as a result of liver disease or obstruction of the common bile duct In pancreatic disease the stools are soft and light in color and contain an abnormal amount of fat. Foamy, soft, foul-smelling stools occur in sprue and steatorrhea. This is due to a disturbance of carbohydrate digestion in the intestinal tract Gross bright red blood in the stool usually indicates that it is coming from a lesion low in the intestinal tract. The most common cause of this type of stool is hemorrhoids (piles). As a rule, hemorrhoids cause bleeding only when the stool is hard due to constipation. The blood is on the surface of the stool and not mixed with the feces If diarrhea is associated with bleeding of the digestive tract, the lesion may be in the upper portion of the small intestine and the stools still contain bright red blood In most cases blood coming from lesions high in the tract change color and become black due to bacterial and enzyme action. This is called a tarry black type of stool Some drugs (iron, bismuth) may also produce tarry black stools. It is important to ascertain the cause of stools being tarry black. If drugs can be excluded, they are a definite indication of pathology of the in-

CHAPTER 22

LABORATORY DIAGNOSIS (Continued)

EXAMINATION OF THE FECES

Stool examinations are important in the diagnosis of gastrointestinal diseases. Routine analysis of the feces consists of a gross and microscopic examination. Bacteriological examination and chemical analysis are used only in special cases. For routine examination, a specimen may be collected on the finger cot used during rectal examination or the patient may defecate into a small paper carton. For bacteriological examination the specimen is collected in a sterile container. To make an examination for amebae, the specimen is kept warm and taken to the laboratory immediately. It is best to notify the laboratory ahead of time so that the specimen can be examined without delay If the specimen is allowed to cool, the amebae lose their motility. To examine for worms, the entire specimen is collected. To make a chemical analysis for blood, the patient should be on a meat-free diet for two or three days. This is done to remove all hemoglobin-containing food that will give false positive reactions However, this is not a routine procedure for most stools are examined for blood without preliminary food restrictions, and the results obtained are accurate enough to suggest the presence or absence of gastrointestinal bleeding.

Macroscopic Examination.—Normally an adult will pass 100 to 200 grams of feces over a twenty-four hour period The volume of stool produced depends upon the type and amount of food consumed and the amount of water consumed. For example, an individual on a vegetable diet has larger stools than an individual on a meat diet If absorption is defective

muscle fibers, starch, fat particles, and other food remnants indicates pathology of the intestinal tract affecting its power to digest food normally. For example, the number of meat fibers is increased in such diseases as sprue and idiopathic steatorrhea.

Chemical Examination.—This consists of examination for blood which cannot be seen by inspection (benzidine test), and chemical tests for fat. An increase in the fat content of feces is found in such diseases as steatorrhea and pancreatic insufficiency due to cancer or stones obstructing the pancreatic duct.

Bacterial Examination.—Normal stools contain an enormous number of various types of bacteria. The most common organism is the colon bacillus. For a bacteriological examination a loopful of feces is smeared on Endo's culture medium and incubated for twenty-four hours. The colonies of pathological bacteria that grow are studied and identified by their characteristics and then replated for further study. The different bacteria thus isolated are further identified by agglutination with immune serum and through their ability to ferment various types of sugar (lactose, dextrose, sucrose, etc.).

Bacterial examination is usually done for the purpose of isolating bacteria of the typhoid-salmonella-shigella group, cholera vibrio, and tubercle bacillus Although the tubercle bacillus may come from tuberculous lesions of the intestinal tract, they usually come from sputum swallowed by patients with pulmonary tuberculosis.

testinal tract. In general, blood from the lower part of the intestinal tract produces stools that are dark brown or red in color.

Small amounts of blood mixed with the feces cannot be seen on gross examination of the stool. To detect its presence, a benzidine test must be done. This test is significant only after the patient has been on a meat-free diet for two to three days

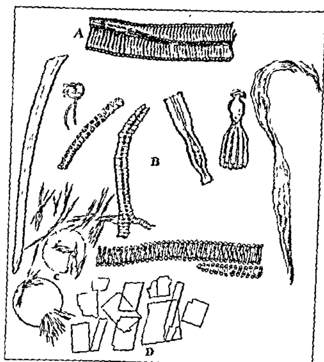


Fig. 46.—Microscopic findings in feces *A* and *B*, vegetable fiber remnants, *A*, banana, commonly mistaken for tapeworm section; *C*, fatty acid crystals, *D*, cholesterol crystals. (From Gradwohl *Clinical Laboratory Methods and Diagnosis*)

Microscopic Examination.—A small amount of feces is mixed with a drop of water placed on a slide and covered with a glass cover slip The slide is carefully examined for the presence of ova of the different intestinal parasites. The presence of an abnormal number of pus cells and red cells indicates inflammation of the digestive tract as occurs in ulcerative colitis, bacillary dysentery, and ulcerating cancer of the rectum or sigmoid region. The finding of undigested

Smears are prepared upon glass slides. The process consists of spreading the material on the slide, drying it in the air, fixing the preparation with heat, and then staining. Usually two such slides are made. This is done in case more than one staining method is used.

Living bacteria may be studied in what is called the wet or *"hanging drop" preparation. A loopful of material is mixed* with a drop of normal saline and placed directly upon a cover slip. The cover slip is then placed over the concavity in the "hanging drop" slide and studied with the microscope.

Bacterial cultivation is carried out on artificial media which are suitable to the growth of bacteria. Under sterile conditions, a loopful of the specimen is placed on the culture medium and kept at body temperature in an incubator for twenty-four hours.

Smears and Cultures From the Eyes, Ears, Nose, Throat, and Mouth.—Specimens obtained from these orifices always contain a mixture of bacteria. Many of these organisms are normally present The specimen is obtained on two cotton-tipped wooden applicators. One is used to make the smear and the other is used to make the culture. If there is a membrane on the mucous membrane wall, sterile forceps are usually used to remove a small piece which is placed in a sterile tube.

In many hospitals it is a routine procedure to take specimens from the throat in patients ill with an upper respiratory infection.

Tonsillitis is the most common cause of sore throat It may be caused by any of the organisms living in the upper respiratory tract The staphylococcus and streptococcus are the bacteria most commonly found in tonsillitis It is difficult to distinguish acute tonsillitis from diphtheria by the gross appearance of the membrane that appears in the throat Smear and culture methods are always used to make the diagnosis In tonsillitis the tonsils may be swollen and red and covered with yellow-white patches that are easily removed from the surface of the tonsil. In diphtheria the tonsils are usually not swollen and the membrane that appears in the throat is dusky gray, clings to the tonsils, and leaves a bleeding surface when removed.

Diphtheria is caused by the organism *Corynebacterium diphtheriae.* Smears and cultures are made from the throat, tonsils,

CHAPTER 23

LABORATORY DIAGNOSIS (Continued)

BACTERIOLOGICAL DIAGNOSTIC METHODS AND TESTS

Bacteriology is the science and study of bacteria (germs). Since bacteria are the most frequent cause of [illegible] iology is an essenti[illegible] [illegible] that gain entrance to the [illegible] the outside (exogenous) and by bacteria present in the body (endogenous). This latter group of organisms may exist in the body without producing symptoms and signs of infection if they are of low disease-producing power (virulence). When an individual's resistance to infection is lowered, as by a head cold, these bacteria with low virulence may be able to grow and multiply. This multiplication of bacteria produces infection. When bacteria which are virulent and capable of producing disease are found in an individual who does not have the symptoms and signs of disease, that person is called a carrier

Bacteria are identified by several methods: smears, wet preparation cultures, serological tests, and by animal inoculation. Smears and cultures are made from mate[illegible]al obtained from wounds, absces[illegible] [illegible]nd pleural, [illegible]es, mouth, [illegible] The ma[illegible] [illegible] a platinum wire loop, aspirating needle, or sterile cotton swab A specimen that is to be used for culture must be obtained under sterile conditions and placed in a sterile container. Since the nurse is frequently responsible for the care and collection of bacterial specimens, she should be well trained in the different techniques

The purulent material contains neutrophiles, bacteria, and epithelial cells. In allergic conditions numerous eosinophiles are found in the exudate. Gram-negative gonococci are found in gonorrheal conjunctivitis. The pneumococcus is sometimes *associated with corneal ulcerations. The Koch-Week's bacillus,* a gram-negative bacillus, causes the acute epidemic conjunctivitis commonly known as "pinkeye." These organisms will be found both in the cells and in the purulent fluid.

Staphylococcus albus and the *Bacillus xerosis* are of no clinical significance for they are normal inhabitants of the mucous membrane of the eyes.

Normally the middle ear is free from bacteria. When infection (otitis media) occurs, pus forms. When it is severe, the eardrum may rupture. Frequently the eardrum must be punctured to allow drainage. The purulent material obtained is important in making a specific diagnosis The bacteria found are usually the same as those found in the throat: streptococci, staphylococci, diphtheria bacilli, and Friedlander's bacilli. Occasionally typhoid bacilli, colon bacilli, and *Bacillus pyocyaneus* are found.

Examination of Sputum.—The sputum of normal individuals contains numerous bacteria These are usually nonpathogenic. In diseases of the lungs such as pneumonia, it is important to know what pathogenic bacteria are found in the sputum for one of them may be the cause of the infection. In most cases routine smears are done on the sputum to determine which organism predominates. Gram's stains are used to determine the type of organism and to classify it according to the dye with which it stains. Gram-positive bacteria stain blue, and gram-negative bacteria stain red. If the bacteria can be identified by smear, a culture is made. A small portion of the sputum is selected, washed in saline, and placed on artifical culture media. The media used depend upon the type of bacteria found in the sputum. Many different types of pathogenic bacteria may be found in the sputum · streptococci, staphylococci, pneumococci, tubercule bacilli, *Hemophilus influenzae,* and *Hemophilus pertussis.* The tubercle bacilli and pneumococci are the most important.

Pneumococci can be identified by their cultural characteristics and by typing by the Neufeld method

and nasal secretions. These are stained with Loeffler's methylene blue. Cultures are made on Loeffler's blood serum and incubated for twenty-four hours. On stained smears diphtheria organisms will appear slightly curved, or irregular in size and outline, clubbed at one or both ends, with circumscribed points in which protoplasm is deeply stained. Smears made from a positive culture will show the diphtheria bacillus.

Streptococcal sore throat is caused by a streptococcal organism (beta hemolytic streptococcus). This organism receives its name from its ability to hemolyze red blood cells. When grown on blood agar media, a zone of hemolysis appears around the beta hemolytic streptococcal colonies. In scarlet fever another type of streptococcus invades the mucous membrane of the throat. It has different characteristics. When it is found in normal individuals, they are considered to be carriers of the disease.

Meningococcal organisms are found in the throat and nasopharynx of many normal persons during epidemics of meningococcus meningitis. They act as carriers. To detect the presence of meningococcal organisms, smears and cultures are made routinely from the mucous membranes of the throat and nasopharynx. The organism is gram-negative (stains red with Gram's stain). It can be differentiated from other diplococci by its cultural characteristics and agglutination tests.

Trench mouth or Vincent's infection is caused by a combination of two organisms: a corkscrew-shaped spirochete and a large spindle-shaped fusiform bacillus. In making smears for identification of these organisms, material must be taken directly from the ulcers on the gums and placed immediately on the slide and stained. This is necessary for the organisms soon break up and lose their characteristics They can be grown on culture media, but this usually is very difficult. Unless these organisms are found in large numbers and appear to be predominant, they are of no clinical significance, for a few of them are normally found in the mouth.

Before material is removed from the eye for examination, the surrounding skin should be cleaned with normal saline to remove the purulent material that has dried and stuck to the skin. This material usually contains many contaminating bacteria which make it unfit for examination. Fresh material should be obtained directly from the conjunctiva or cornea.

The material is obtained in the first stage of syphilis from the primary ulcer (chancre) which is usually located on the genitalia but which may be found elsewhere on the body (lips). In the secondary stage the primary chancre heals and the specimen must be obtained by aspiration from swollen lymph nodes, where the spirochetes usually localize, or from mucus patches or the maculopapular rash that appears on the skin.

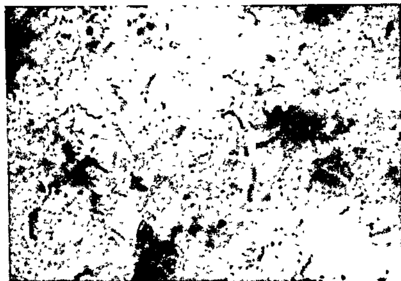


Fig. 47.—*Treponema pallidum*, microscopic study, showing sharp spirals and pointed ends. (Courtesy of Dr Gregory Shwartzman, New York City; Medichrome, Clay-Adams Co , Inc)

Under dark-field illumination the spirochete of syphilis appears as a slowly moving tight corkscrew Its curves are small and regularly spaced and are ten to fifteen in number.

In obtaining the material for examination, the worker must be cautious and wear rubber gloves for the material is very infectious. The skin surrounding the ulcer is cleansed with sterile gauze and water. The material may be removed from the ulcer by one of two methods either by scraping the surface of the lesion or by drawing the material up into a special type of pipette with a rubber bulb. The material is placed directly on a slide and a cover glass applied The slide should be examined at once

Every sputum obtained from patients should be examined for tubercle bacilli. To demonstrate the tubercle bacillus on smears, the Ziehl-Neelsen stain is used. It will appear as a small, slender or curved bright red rod. It may appear singly or in groups. When found, it is a positive indication of tuberculosis. In cases suspected of tuberculosis it is frequently difficult to find. To facilitate its demonstration, the sputum is treated with sodium hydroxide to remove the mucus and then is *centrifuged*. The sediment in the bottom of the test tube is removed and smears are made and stained. If necessary, this concentrated specimen may be used for guinea pig inoculation.

Examination of Pus From the Genitourinary Tract.—Many bacteria (staphylococci, streptococci, and colon bacilli) may be found in the purulent discharge from the urinary tract, but the most common organism found is the gonococcus If the gonococcus is not found after frequent examinations and the pus contains numerous white cells, the condition is said to be "nonspecific." This means that the infection is not due to the gonococcus but to some other organism.

In males, material is obtained by stripping the urethra or by prostatic massage. This is placed on a slide and stained with Gram's stain. The gonococci are identified by their coffee bean diplococcal appearance and their presence inside the white cells (intracellular). They are gram negative and stain red. If their identification is in doubt, culture methods should be used for further diagnosis.

In females, smears are made from the vagina, urethra, and cervix. *Trichomonas vaginalis* is a common cause of purulent vaginitis. This organism is best identified in a wet preparation. Material is obtained on a wire loop from the vagina and mixed with a drop of normal saline on a slide. The organism is a flagellate and motile so it is easy to detect. Stained smears and dark-field examination are also used to differentiate the organism from other bacteria in the vaginal secretions

Examination for Treponema Pallidum (Spirochetes of Syphilis).—This organism is identified by dark-field examination. Material obtained from suspected syphilitic lesions is placed under a microscope that has an indirect light, causing illumination of particles against a dark background.

CHAPTER 24

LABORATORY DIAGNOSIS (Continued)

SEROLOGICAL DIAGNOSTIC TESTS

Serological diagnostic tests are based upon a specific reaction called the antigen-antibody reaction. An antigen is a foreign substance (bacterium, virus, foreign protein, or animal parasite) that, on invasion of the body, stimulates the living body tissues to produce another substance (antibody). An antibody is any substance produced by the living body tissues in response to stimulation by an antigen. When a person develops an infection, the body reacts and forms "immune bodies" or antibodies. These combat the disease-producing agent or its toxin. There are many kinds of antibodies, but each antibody is specific since it is the body's characteristic response to one particular antigen In general, an antibody will react against only the antigen that stimulated its formation. This factor, when used under controlled circumstances, is the basis of serological diagnostic tests. It is used as a diagnostic procedure when the search for the disease-producing agent has been unsuccessful The tests are designed to discover the presence of antibodies in the serum or to discover whether the suspected antigen will react with known antibodies.

Serological diagnostic tests are also used to help in the diagnosis of virus disease. Specific antibodies are produced by the virus in the same manner as those produced by bacteria.

Another substance (complement) found in normal blood is often required for a complete union of the antigen and antibody in the antigen-antibody reaction. It is a thermolabile

Blood Cultures.—Bacteria frequently enter the blood stream. They are then found by blood culture. When bacteria are found in the blood stream and there are associated manifestations of infection, the condition is called septicemia. When the bacteria in the blood stream become lodged in various organs (kidneys) and produce localized multiple abscess, the condition is called pyemia. Bacteria in the blood stream without evidence of infection is called bacteremia.

It is best to take blood for culture when the temperature is elevated or when there is a rise in the temperature (blood is drawn just before the temperature reaches its peak). The method consists of sterilizing the skin over the decubital vein with alcohol and iodine and removing 8 to 10 cc of venous blood with a sterile syringe. This is mixed with sterile culture media. In most cases this procedure is carried out at the bedside since it requires less handling of the specimen and reduces the chance for contamination. The blood is placed in an incubator and kept at body temperature. It is examined at the end of twenty-four hours for the appearance of bacteria colonies. A blood culture is always kept for at least one week before it is reported negative.

Positive blood cultures may be found in typhoid fever during the first week. In subacute bacterial endocarditis repeated cultures may be necessary.

In septicemia blood cultures are frequently positive. The most common bacteria found are streptococci, staphylococci, and pneumococci. *Streptococcus viridans* may be isolated in the majority of cases of subacute bacterial endocarditis. Septicemia may also occur in osteomyelitis and abscesses located any place in the body.

Bacteremia is common in pneumonia, typhoid fever, undulant fever, local skin abscesses, and boils

reaction because the organism that causes syphilis (*Treponema pallidum*) is not used as the antigen. The antigen used is an extract from beef heart muscle. The terminology used in this test is different from that used on p. 306, and the two concepts should not be confused. The test rests upon the empirically known fact that if an extract of beef heart, serum from the patient, and guinea pig serum are added to a mixture of rabbit serum which has been sensitized to sheep red cells, the red cells will not become hemolyzed if the patient has syphilis; if the patient does not have syphilis, hemolysis will occur.

This test is theoretically explained as follows: If the patient has syphilis, his serum contains a substance which acts as an amboceptor (i.e., one which takes both); that is, it unites into a "system" with beef heart substance on one hand, and, on the other, with a substance in guinea pig serum which for the purpose of the test is called "complement." This system has no particular function or characteristics by which it, in itself, can be recognized. It must, however, be remembered that there is only a finite quantity of complement, and it is completely consumed by this reaction

Now we take up another train of thought If washed sheep red cells are repeatedly injected into a rabbit, the rabbit's serum will acquire a peculiar characteristic If to this serum is added some sheep red cells *and* complement such as that contained in guinea pig serum mentioned above, the red cells will become hemolyzed, but *only* if complement is present

Now, if "system" (containing the serum of a patient with syphilis) is added to a mixture of guinea pig serum and sheep red cells, nothing will happen, because the amboceptor in the syphilitic patient's serum has immobilized the complement. However, if the serum is from a patient who does not have syphilis, his serum contains no "amboceptor" The complement is, therefore, left free to combine with the rabbit serum and the sheep red cells and now hemolysis does occur, because complement is available

Thus, hemolysis means free complement because the syphilitic amboceptor is absent and does not take the complement, so the patient whose serum is being tested does not have syphilis Conversely, the lack of hemolysis means that a syphilitic amboceptor is present and has consumed the complement which now no longer is available for the system which pro-

(easily destroyed by heat) substance. For the antigen-antibody reaction in the Wassermann test to be complete, complement must be present.

The antigen-antibody reaction may be demonstrated in a number of different ways. These are the complement fixation, agglutination, precipitation, and neutralization tests and opsonic reactions.

Serological tests must be performed with laboratory equipment that is chemically clean and dry. These tests are sensitive in their reactions, and any outside contamination with chemicals or foreign material will interfere with the antigen-antibody reaction. After the blood has been drawn from the patient, it should be placed in the refrigerator in a slanting position to allow it to clot. The serum is removed with a pipette. Care should be taken at all times to prevent the hemolysis of the red blood cells.

Complement Fixation Test.—This test is based upon the fact that disease produces a reaction in the serum of the patient which results in the production of a substance called the hemolytic amboceptor. This substance is not present in normal individuals The reaction that takes place in the test depends upon this amboceptor which may cause hemolysis of red blood cells or the destruction of bacteria (bacteriolysis), according to the antigen used. The hemolytic amboceptor is formed by the living tissue cells of the body as a reaction to many different diseases. It is formed in such diseases as syphilis, tuberculosis, gonorrhea, typhoid fever, *T. echinococcus* (hydatid), parasitic infestations (trichiniasis), Weil's disease, and diseases caused by the meningococcus, staphylococcus, and streptococcus groups of organisms. The test is used on occasions in diseases caused by fungi (actinomycosis and blastomycosis). The complement fixation test may be useful in such virus diseases as epidemic encephalitis and poliomyelitis. In typhus and rickettsial diseases the test may be used to detect previous infection. Since the test is a very long and tedious procedure and is not too specific except for syphilis, it is used little except in the diagnosis of syphilis

The best known complement fixation test is the Wassermann test for syphilis. It is used to test both the cerebrospinal fluid and blood serum. However, the test is a nonspecific biological

of the tube. The agglutination test may be done on glass slides and the results determined by examination with the microscope.

The Widal agglutination test for typhoid fever is the best known of the agglutination tests. Patients with typhoid fever *develop antibodies (agglutinins) seven to ten days after the* onset of recognizable symptoms and signs. These reach their highest concentration in the serum during the third, fourth, and fifth weeks. Positive agglutination in high dilutions (titer) of the patient's serum is significant. However, a positive reaction in low dilutions should not be discarded. If the agglutination occurs with increasing dilution on successive days, the patient is said to have a rising titer. This indicates that he has the disease for which he is being tested It is therefore important that the Widal test be done early and repeated frequently. The test is positive if the suspension of typhoid *bacilli* is agglutinated by the patient's serum in a 1:50 dilution followed by a rising titer to 1:100 Individuals who have had a recent typhoid vaccination will show positive agglutination reactions in high titers.

Paratyphoid A and B and the colon bacilli also give positive Widal tests. The agglutination test is also used in diagnosing a variety of diseases. Agglutination tests are frequently done in Asiatic cholera, plague, undulant fever, bacillary dysentery, tularemia, Weil's disease, and whooping cough.

Weil-Felix Test.—This test is similar to the agglutination tests but *is used in the diagnosis of rickettsial diseases such* as Rocky Mountain spotted fever and typhus Since the rickettsiae which cause these infections are very difficult to work with, a strain of nonpathogenic bacillus is used for the antigen. This makes the Weil-Felix test a nonspecific biological antigen-antibody reaction The test is done by mixing the patient's serum with a culture of *Bacillus proteus*. If agglutination occurs in a titer of 1.80, the test is positive and suggestive of infection. A titer of 1·160 or 1·320 is usually diagnostic.

Precipitin Tests.—These tests are also antigen-antibody reactions as are the agglutination tests. The antigens form a precipitate (flocculation) when they react with the antibodies. The precipitate which forms in positive reactions is a visible

duces hemolysis. If syphilitic amboceptors are absent, the complement remains free, and it causes hemolysis of the sheep red cells. This is called a negative test.

In untreated adults with syphilis the Wassermann test is positive in 65 to 95 per cent of the cases. The blood test becomes positive four weeks after the appearance of the primary sore (chancre). In the secondary stage, the blood test is positive in 90 to 100 per cent of the cases. In the third stage (tertiary syphilis), 50 to 70 per cent of the cases have a positive blood test. Before a diagnosis of syphilis can be made, the patient should have several Wassermann tests, all of which must be positive. Also, it is important to obtain a clinical history or clinical evidence of syphilis.

The Wassermann test on the cerebrospinal fluid is negative unless there is involvement of the central nervous system. The Wassermann test may be positive in the spinal fluid and negative in the blood.

Patients under treatment for syphilis may have a negative Wassermann test before they are cured.

Patients with congenital syphilis may have positive Wassermann tests throughout life even though they have been treated and are clinically cured.

Precaution must be taken in making the diagnosis of syphilis from positive blood tests alone Certain diseases will give false positive Wassermann tests. They are yaws, leprosy, malaria, infectious mononucleosis, acute infections with high fever (pneumonia), and diseases producing jaundice. In most cases false positive tests give weak reactions.

Agglutination Tests.—The agglutination test is the most widely used serological diagnostic test. It is used to determine the presence of specific antibodies in serum that will cause bacteria (antigen) to form clumps (agglutinate). The bacteria used for the antigen are organisms that have been grown in pure culture in the laboratory The agglutination test consists of adding equal amounts of a formalized bacterial suspension to increasing dilutions of the patient's serum. If the dead bacteria form clumps and fall to the bottom of the test tube, leaving a clear supernatent fluid, it is called a positive reaction. A negative test will be cloudy and lack sediment in the bottom

antibodies Opsonins do not attack the bacteria but by some action on the organisms they make them more easily ingested by the polymorphonuclear leukocytes.

The ability of the polymorphonuclear leukocytes to ingest invading bacteria is a measure of the opsonic content of the serum. This is also a measure of the immunity of an individual.

This test is frequently used in determining previous infection, immunity, and susceptibility of an individual to such diseases as tularemia, brucellosis (undulant fever), and pertussis (whooping cough).

Neutralization or Protection Test.—This test is of particular value in diagnosing virus diseases. The serum of the patient is mixed with a known culture of virus and then injected into an animal (guinea pig or mouse). The injection is made into the brain or peritoneal cavity or other parts of the animal's body, depending upon the type of virus used. The animal is observed to see whether it develops the disease or dies. If the animal does not become sick, the patient's serum is said to contain specific antibodies for the virus used.

During the last few years a new method utilizing the chorioallantoic membrane of the chick embryo instead of animals has come into use.

Typing of Pneumococci.—Neufeld and Handel, in 1910, discovered that the pneumococci were serologically different. This difference is due to a capsule that surrounds the organism. The cell body of the bacteria contains proteins and lipoids. The capsule contains polysaccharides that produce type-specific substances in the blood These substances are called half antigens or "haptenes." The "haptenes" differ from most antigens in that they do not stimulate the production of antibodies. However, they will react with immune serum obtained from a patient who has recovered from a pneumococcal infection or with a specially prepared rabbit serum So far, some thirty-two different types of pneumococci have been recognized.

The test consists of taking a small sample of sputum containing pneumococci and adding immune serum. If the immune serum is type specific for the organisms, the capsule will become swollen. This is called the "quellung" reaction. If

"white cloud." It is made up of proteins. The antigen is called a precipitinogen. The antibody is called a precipitin.

Precipitin tests are commonly done on serum and spinal fluid in the diagnosis of syphilis. They are known by the name of the individual who developed the test—Kahn, Kline, Kolmer, and Hinton. These tests have replaced the Wassermann test in many hospitals because they are much easier to do.

Many diseases can be diagnosed by the precipitin tests They are used in diagnosing diphtheria from throat cultures or swabs, typhoid fever and bacillary dysentery from filtrates of stools, meningococcal meningitis, plague and anthrax from filtrates made from the infected flesh, and parasitic diseases (ascaris, ameba, trichina, malaria, and echinococcus).

The precipitin test is very important and useful in diagnosing echinococcal disease. Fluid is removed from the hydatid cyst and mixed with an equal amount of the patient's serum. If a flocculent precipitate appears within thirty minutes, the test is positive.

Paul-Bunnell Test or the Heterophile Reaction.—This test is based on the fact that the serum of patients with infectious mononucleosis contains antibodies that will agglutinate sheep red cells in high titers. These antibodies are called "heterophile antibodies." The serum of normal persons also contains heterophile antibodies but only in low titers (1:8) A high titer of heterophile antibodies will appear in individuals after administration of horse serum Mild agglutinations of the sheep red cells may occur in cases of myelogenous leukemia.

This test consists of mixing equal amounts of sheep red cells with varying dilutions of the patient's serum. Agglutination of the sheep cells above a titer of 1:32 is suggestive of infectious mononucleosis. If repeated tests show a rising titer, it is diagnostic.

Opsonocytophagic Test.—An opsonin is an antibody that appears in the blood in response to infections or specific immunizations after vaccination such as for typhoid fever. Opsonins appearing in the blood after a specific infection such as typhoid fever are called acquired antibodies. Opsonins appearing in the blood and having the power to resist any specific infection without having had any previous infection may be due to a natural heritage of the individual. These are called natural

CHAPTER 25

DIAGNOSTIC SKIN TESTS

Introduction.—Skin tests are diagnostic procedures used to determine if an individual is immune to certain diseases or if he has been sensitized to certain antigenic agents (proteins) by previous contact or exposure. The three methods used are the cutaneous (scratch and patch tests), intracutaneous (intradermal), and conjunctival tests.

The cutaneous scratch method is the method most commonly used. It consists of making small abrasions on the surface of the skin into which a small amount of antigen is rubbed. A positive test is indicated by redness and itching at the scratch site. If the test is positive, a skin reaction will appear within twenty minutes. This type of test is best used for determining hypersensitivity to foods, drugs, and plant pollens.

The cutaneous patch test consists of placing a small piece of cloth impregnated with antigen directly on the surface of the skin. If the patient is sensitive to the antigen, the skin becomes red. This method is commonly used to test individuals who develop a contact dermatitis; for example, telephone operators who handle copper-plated plugs on the switchboard wires.

The intracutaneous or intradermal test, although a more sensitive test, may be used when the antigens in the scratch test fail to give reactions. This test consists of injecting a small

However, it may take several hours or days.

the capsule does not swell, immune serum made from the othe types of pneumococci is used. The test is repeated until th type of immune serum is found that will make the capsul swell.

This test is important in determining the type of pneumo cocci that is causing the patient's illness. Knowing the typ of pneumococci will determine the treatment to be used—sul fonamides, penicillin, or antipneumococcic serum.

This type of test may be used to determine the type of H *influenzae* which might be causing the patient's disease. Thes organisms also contain a polysaccharide in their capsule. Th test is done with sputum, cerebrospinal fluid, or nasal secre tions obtained from the patient.

(O.T.) or a purified protein derivative (P.P.D.) made from old tuberculin. The antigen is injected into the skin on the flexor surface of the forearm. The dosage used is very small (0.1 cc) (0.00002 mg.). The test is called positive if an area of redness with edema appears forty-eight hours or more after the injection. A positive reaction means that the individual has at some time been infected with tubercle bacillus or that he is infected at the present time. The lesion in the body may be healed or active. However, a positive reaction does not mean that active tuberculosis is present or has ever existed. A negative reaction does not rule out disease for it may occur in miliary tuberculosis and rapidly spreading lesions. The tuberculin test is of more value in young children than in adults.

Similar tests are used to detect sensitivity to other bacteria. For example, brucellosis (undulant fever), tularemia, and chancroid. The antigen used is a suspension of specific organisms. The test is made by an intracutaneous injection of the antigen.

Skin tests may be very useful in making the diagnosis of many types of parasitic infections. The antigen used is an extract made from the parasite larvae Positive skin reactions may occur in such diseases as trichinosis, filariasis, schistosomiasis, leishmaniasis, and those caused by *Enterobius vermicularis*. The antigen used to detect echinococcal disease is made from sterile fluid aspirated from the hydatid cyst.

Tests for Antibody Formation.—The two most common tests are the Dick test for scarlet fever and the Shick test for diphtheria These tests are not based upon a sensitivity reaction but upon the neutralization of a toxin by a specific antitoxin If a toxin is injected into the skin, it produces an area of inflammation unless it is neutralized by a specific antitoxin. Therefore, if a skin reaction occurs, it indicates that the individual does not contain the specific antitoxin and is not immune to the disease

The Dick test consists of injecting intradermally 0.1 cc of Dick toxin on the flexor surface of the forearm. The arm is examined for a reaction at the end of twenty-four hours A positive reaction is one that shows an area of redness 1 cm. or more in diameter A positive reaction means the individual

The conjunctival or ophthalmic test consists of instilling an antigen into the conjunctival sac. If positive, itching, redness, and lacrimation will appear within thirty minutes. This test is used to determine sensitivity to horse serum and drugs to be used for treatment (penicillin) and certain laboratory procedures (such as Diodrast which is injected intravenously for taking x-ray pictures of the kidneys).



Fig. 48.—Very strong scratch reactions on the arm. A total of nine very strong reactions to one-fiftieth pollen extracts occurred simultaneously on this patient's arm. The possibility of such occurrence illustrates the desirability of performing this type of test on an extremity. In the event of constitutional reaction a tourniquet may be applied above the site of local reaction. This could not be done on the back. (From Vaughan and Black: Practice of Allergy, The C. V. Mosby Co.)

Tests for Hypersensitivity to Bacteria and Animal Parasites.—These tests are usually done by the intradermal or patch method. The antigen used depends upon the type of bacteria being studied. The antigen may consist of a suspension of dead bacteria (vaccine), a solution of the bacterial waste products after the bacteria have been removed, or a solution of protein obtained from the bacteria. For a skin reaction to take place, a specific antigen of the bacteria being investigated should be used.

The most common tests are those used for tuberculosis—cutaneous test (von Pirquet), intracutaneous test (Mantoux), ophthalmic test (Calmette), and the patch test (Vollmer). The intracutaneous method of Mantoux is the test most frequently used. The antigen used may be either old tuberculin

CHAPTER 26

X-RAY EXAMINATIONS

Introduction.—Since the discovery of x-rays by Roentgen, they have become increasingly important as a diagnostic aid. They *make it possible to study the different organs* of the body. With the present-day modern machines and techniques used, most of the organs of the body can be visualized. X-rays are most commonly used to study the skeletal system, lungs, and gastrointestinal and genitourinary systems. To study the digestive and urinary tracts, suitable media such as barium and Diodrast must be used to outline the tracts. Frequently, pictures (stereoscopic films) taken at slightly different angles are used to indicate the depth of lesions Fluoroscopy is used to study the movement of the digestive tract and diaphragm and movement of fluid levels in the lungs It is also used as a guide in setting fractures.

Skeletal System.—X-rays are most commonly used to detect evidence of a fracture. A fracture is a break in the continuity of the bone. In most cases a fracture is very easy to detect by x-ray; however, it may be so fine that it is almost invisible On the x-ray film, at the fracture site, there is a change in the normal bone texture, the regular bone trabeculations are compressed, and there is a thin black line that runs through the bone The black line is the line of fracture. The fracture site appears black since the obstruction due to the bone that stops the penetration of the x-rays is removed by the line of breakage.

X-rays are also used to detect dislocations or displacement of bones as compared to their normal anatomical relation to each other.

The only way the doctor can tell if the bones at the site of fracture are healing and knitting together is by taking x-rays

is susceptible to scarlet fever. A negative reaction means the individual is immune to scarlet fever.

The Shick test is used to determine susceptibility to diphtheria. The test consists of injecting 0.1 cc of diphtheria toxin intradermally into the skin. The reaction is read at the end of twenty-four to thirty-six hours. If an area of redness appears and contains a hard center, it is called a positive reaction This means that the individual is not immune to diphtheria.

Tumors of the bone may be benign or malignant. Common benign tumors are the exostoses. These are irregular bony growths that appear at the end of the long bones where the ligaments are attached. Malignant tumors may arise from any of the bone cells. In general, malignant tumors destroy the bone and spread to involve the soft tissue. On x-ray the bone appears thin and moth-eaten. The tumor mass can be outlined as an irregularly shaped fuzzy opaque mass attached to the bone. If extensive, the shaft of the bone appears cystic and has a cauliflower appearance.

Contrast Studies of the Brain (*Air Studies*).—These are x-ray studies of the brain after the cerebrospinal fluid has been removed and replaced by air. There are two types: encephalography and ventriculography.

1. **Encephalography:** In encephalography a few cubic centimeters of spinal fluid are removed and air injected into the spinal canal. The patient is kept erect in a sitting position and x-rays (encephalograms) are taken of the head. The injected air will partially fill the ventricles and subarachnoid space which appear black in color The ventricles are outlined (appear black) and surrounded by brain tissue If the ventricles are irregular in shape, enlarged, dilated, or distorted, it indicates the presence of such lesions as brain tumors, cysts, or old hemorrhage

2. **Ventriculography:** In ventriculography several cubic centimeters of cerebrospinal fluid are removed from one of the ventricles through an opening made in the skull. The patient is kept in the horizontal position and x-rays (ventriculograms) made. The ventricles are outlined. This method is used for the sole purpose of locating brain tumors

Sinuses and Mastoids.—These are air-filled cavities found in the skull. Normally they produce irregularly shaped dark areas on the x-ray film.

Routine sinus films include all the sinuses—frontal, maxillary, sphenoid, and ethmoid. When the sinuses become infected, the mucous membranes covering the sinus walls become swollen and inflamed. On x-ray film the sinus cavity appears gray, as though filled with smoke. Tumor masses appear as gray outpouchings that are attached to the sinus wall

of the fractured area at regular intervals. As the bones heal, the black line becomes fuzzy and gradually fills in until it disappears. This is due to the formation of new bone (callous formation) that appears as a fusiform swelling at the edge of the bone and covers the site of fracture.

Bacteria may affect bone in the same manner as they do the lungs and soft tissues of the body. The most common infection of bones is acute pyogenic osteomyelitis. This is caused by pyogenic organisms such as streptococci and staphylococci. The long bones of the legs and arms are the bones most frequently involved. Bacteria enter the center canal (medullary canal) of the bone, grow and spread if they remain unchecked. The toxins produced by the bacteria cause erosion of the bone and may even perforate the bone cortex. When this happens, the pus reaches the covering of the bone (periosteum), it is worked loose and finally broken through into the soft tissues (muscles); finally an abscess appears on the surface of the skin. When the periosteum becomes involved, it is stimulated to new bone formation called involucrum. If the infection remains unchecked, the blood circulating in the bone is shut off, and this causes the bone to die. This dead tissue is called sequestrum. On x-ray the sequestrum appears chalky white. The normal bone that is left shows small irregular black areas due to absorption of calcium salts This is called osteoporosis.

Glandular or metabolic disturbances may produce a change in the skeletal system as occurs in hyperfunction of the anterior lobe of the pituitary (acromegaly) On x-ray the bones of the entire skeletal system show an increase in size. The texture of the bones becomes coarse and thick The frontal bone becomes prominent. The sella turcica which houses the pituitary gland shows thinning of its bony boundaries which causes it to enlarge. In Paget's disease the bones show first an enlargement and thickening. The skull bones are usually the first bones involved. The bones have a mottled "woolly" appearance. This disease may affect all the bones or remain confined to a single one. In hyperparathyroidism small cystlike areas may appear near the ends of the long bones. The skull bones develop a granular appearance (osteoporosis). This is a result of loss of calcium from the bones.

The earliest infiltrations of tuberculosis are most common in the apices of the lungs. They appear as faint homogeneous shadows, irregular and indistinct in outline, and less than a centimeter in diameter. In advanced tuberculosis, cavities may be made out. They appear as well-defined, ringlike structures, imbedded in a diffuse, hazy area of infiltrated lung. In miliary tuberculosis the lungs are studded with very small, irregular, hazy, circumscribed areas of increased density.

The x-ray examination cannot determine the activity of the lesion. It shows the extent of it. To determine activity of the lesion the patient's symptoms and signs must be used in combination with the x-ray findings.

In lobar pneumonia there is seen a uniform shadow of increased density involving one or more lobes of the lungs. In bronchopneumonia small distinct shadows, regular and irregular in outline, small and large in size, may be seen to involve one lobe or the entire lung field

The shadows cast by pleural effusions are homogeneous, producing a dense uniform shadow at the base of the lung, obliterating the costophrenic angle. The fluid level is concave in shape. In pleurisy the costophrenic angle is slightly hazy, with coarse linear shadows at the lung base. The diaphragmatic movement on the affected side is restricted in both pleural effusion and pleurisy.

The shape and position of the normal diaphragm are subject to many variations Its contour is usually smooth Its position is often an indication of disease, for example, in pleurisy and pneumonia it may be slightly elevated Marked elevation of the diaphragm is seen in subphrenic abscess.

Cancer of the lungs produces shadows of various sizes, depending upon the type They may involve a portion of one lobe or the mediastinal lymph nodes The shadows produced do not have any typical arrangement. Metastatic lesions appear as faint circular homogeneous shadows Benign tumors are difficult to differentiate from malignant masses. In general, benign tumors are well outlined and homogeneous and do not invade the surrounding lung tissue.

In the diagnosis of aneurysm of the thoracic aorta, the fluoroscope is far superior to the x-ray film Large aneurysm of the aorta may displace the heart downward and to the left. The shadow of the aneurysm is very dense and fusiform in shape On fluoroscopy it can be seen to pulsate.

Normal mastoids show a honeycombed structure with the walls of the mastoid cells clearly outlined. Infection of the mastoids (mastoiditis) produces a generalized haziness of the cells.

Teeth.—In the study of teeth, small dental films are used. These are more satisfactory than the large x-ray film holders for they can be put into the mouth. The x-ray study of teeth is important in finding localized areas of destruction of the alveolar margins and root abscesses. These will appear as small, circular gray-black areas at the base of the roots. X-rays are also used to study the position of unerupted teeth In pyorrhea the gums will be seen to be retracted from the teeth.

Thoracic Viscera.—The organs in the chest cage (lungs, heart, diaphragm (mediastinum) may be studied either by fluoroscopy or x-ray films Fluoroscopy is useful for studying the lungs and heart in action. However, it is of uncertain value in the recognition of lung lesions such as tuberculosis. Stereoscopic plates are of value in determining the depth and size of lung lesions.

No two chest films, even of normal individuals, are alike. Variations in the size, shape, and graphic appearance of normal lungs are numerous and vary with the age of the individual. On x-ray films the lungs consist of air-containing alveoli, a network of bronchi, blood vessels, and lymphatics The alveoli do not cast shadows on the x-ray film and are responsible for the blackness of the aerated lung fields. The blood vessels intercept the rays and produce a shadowy network of gray lines that radiate from the root of the lungs, decreasing in distinctness and width toward the periphery of the lung, where they are barely visible. It is common to find certain shadows on the x-ray film that have no relation to disease processes, for example, the shadows cast by female breasts The hilum or root of the lungs shows an irregular mass of shadows which is produced by the blood vessels, large bronchi, and lymph nodes near the mediastinum. The trachea is visible through the upper part of the mediastinum as a gray-black tube. Its bifurcation is seen at the level of the fourth dorsal vertebra The localization of the lobes of the lungs has a great value The lobes are divided by thin-lined fissures which appear gray-white on the film.

and of the left auricle, with a tendency toward a globular shape. In hypertension the heart is egg shaped and blunted at the apex. In arteriosclerosis the aorta is thickened, tortuous, and elongated and may contain small calcified plaques.

Bronchography.—To visualize the tracheobronchial tree on the x-ray film, oils containing iodine (Lipiodol) are introduced into the trachea before films of the chest are made. The oil outlines the air passages and indicates points of *obstruction* and stenosis and dilatation of the bronchial tree (*bronchiectasis*). The oil may be introduced through a catheter placed on the back of the tongue, by the *drop method*, or through a bronchoscope.



Fig. 59. Preoperative x-ray film, lateral view, showing carcinoma of the esophagus. (From Thorek and Neiman: J. Thoracic Surg. July, 1950.)

The method of choice for x-ray study of the heart is the fluoroscope. The x-ray film gives a more distorted image of the heart; therefore it is not as accurate. However, x-ray films are useful in determining the size and shape of the heart.



Fig 49—X-ray of lungs showing lobar pneumonia, seventh day of disease, with massive consolidation of right upper and middle lobes, elevation of the diaphragm, traction of the mediastinum to the side of the lesion and decrease in rib spaces (From Meakins Practice of Medicine, The C. V Mosby Co)

Dilatation and hypertrophy of the heart produce an increase in the size and prominence of the contour of the right and left ventricles. The mechanical changes produced by valvular lesions may be seen in the heart shadow. In mitral heart disease the earliest findings are slight enlargement of the left ventricle with increased prominence of the pulmonary artery

time. Both methods help determine the size, position, shape, and contour of the gastrointestinal tract. The fluoroscope permits the doctor to study the tract in motion and to palpate individual organs. The x-ray films are especially helpful in studying contour and also furnish a permanent record



Fig 52 X-ray of carcinoma of stomach showing polypoid-like mass that has invaded gastric mucosa Note absence of normal rugae (Courtesy Edward Mallinckrodt Institute of Radiology, Washington University School of Medicine, St Louis)

The esophagus is studied for malignant tumors, spasm, strictures, and diverticulum Malignant tumors and strictures cause a narrowing of the esophagus at the site of origin The esopha-

Gastrointestinal Tract.—Since the digestive tract is not directly visible by x-ray, it is necessary to fill the tract with some radiopaque substance that will not interfere with the function of the digestive organs. It must be harmless. The



FIG. 51.—X-ray of stomach filled with barium showing carcinoma; abnormal convexity in fundus. (Courtesy Edward Mallinckrodt Institute of Radiology, Washington University School of Medicine, St. Louis.)

substance used is barium sulfate. In making the examination, the fluoroscope and x-ray films are used in a combination. The doctor observes the action of the esophagus and stomach at the same time that the patient drinks the barium. After this has been done, x-ray films are made at different intervals of

and duodenal. Ulcers appear as projections from the gastric silhouette. They may vary in size and shape. These projections or filling defects are called niches. With long-standing ulcers with scar formation the stomach may become hourglass in shape. There is usually increased peristalsis with spasm of



Fig 54 —Normal evacuation film of colon following barium enema (Courtesy Edward Mallinckrodt Institute of Radiology, Washington University School of Medicine, St Louis)

the pylorus which causes a delay in the expulsion of the barium Cancer may be located in any part of the stomach. There is an irregular filling defect with serrated edges caused by tumor mass growing into the lumen of the stomach

gus fills with barium and assumes a conical shape, with the apex pointed downward. The most common form of spasm is cardiospasm. It results in a dilatation of the entire esophagus



Fig 53—Barium enema of colon showing normal configuration, degree of distensibility, and haustral markings (Courtesy Edward Mallinckrodt Institute of Radiology, Washington University School of Medicine, St. Louis.)

Diverticula are pouchlike sacs that extend outside the esophagus. They fill with barium and persist after the esophagus empties.

The two lesions of the stomach that are most important are ulcers and cancer. Ulcers are of two types: gastric (stomach)

testines are distended with gas above the obstructing lesion and have a herringbone appearance.

Gall Bladder Studies (Cholecystography).—This is a diagnostic procedure used to study the function of the gall bladder. In all cases a flat film of the abdomen is taken to determine the

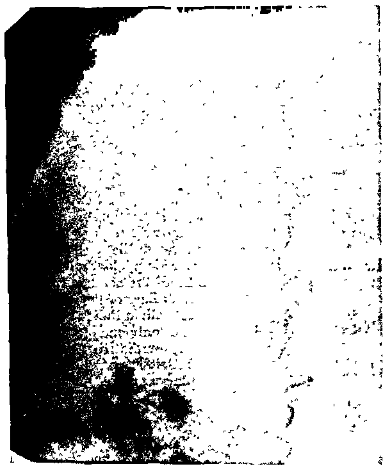


Fig. 56—X-ray showing gall bladder containing several small gallstones (Courtesy Edward Mallinckrodt Institute of Radiology, Washington University School of Medicine, St Louis)

presence of stones For stones in the gall bladder to be visualized they must contain calcium. To outline the gall bladder the patient is given a radiopaque substance, Priodax (iodoalphionic acid). This may be taken orally. This substance is car-

The most important lesions found in the small intestines are ulcers and cancer. Neither of these lesions is very common.

One of the most common findings in the colon are small circular shadows extending beyond the lumen (diverticula). When they are multiple, the condition is called diverticulosis. Cancer of the large bowel is characterized by filling defects.



Fig 55.—X-ray of normal gall bladder filled with dye. (Courtesy Edward Mallinckrodt Institute of Radiology, Washington University School of Medicine, St Louis)

In obstruction of the bowel, administration of the barium meal is contraindicated. Frequently the site of obstruction can be determined by a routine flat film of the abdomen. The in-

CHAPTER 27

SPECIAL EXAMINATIONS

Endoscopes.—These are instruments (metal tubes with light attachments) used for examination of the interior of a canal (rectum) or hollow viscus (stomach). Examination of the organs with these instruments is called endoscopy. Even though x-ray is the most common method of examination of such organs as the esophagus, stomach, rectum, bronchial tree of the lungs, bladder, and peritoneal cavity, it frequently fails to show very small lesions Also x-ray films frequently fail to differentiate between benign and malignant lesions. By using endoscopes, the above-mentioned organs can be viewed directly, and, if necessary, biopsy of lesions taken for laboratory study. However, there are limitations to the use of endoscopes so they should be used in conjunction with x-ray.

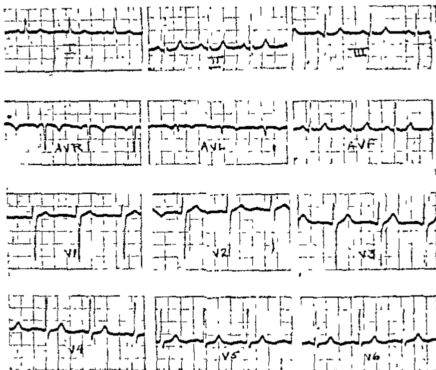
Esophagoscopy.—This is examination of the interior of the esophagus. The esophagoscope is passed into the esophagus, and the walls are examined for the presence of ulcers, varices, and tumors.

Gastroscopy.—The gastroscope is a long, flexible tube that is used to study the interior of the stomach Before the tube is passed it is necessary to rule out any pathology of the esophagus such as esophageal varices. Disease of the esophagus is a contraindication for the passage of the gastroscope. To make the passage of the tube easier, the throat is sprayed with a local anesthetic (2 per cent Pontocaine hydrochloride) Before the gastroscope is passed, the stomach is emptied to remove all the gastric juice that may have accumulated. The most important use of the gastroscope is in the diagnosis of gastritis It is not

ried to the liver, from which it is excreted into the gall bladder along with the bile. It is concentrated by the gall bladder. A normal gall bladder shows a uniform, even border without irregularities. If the gall bladder is diseased (cholecystitis), it is smaller than normal and irregular in outline, and it does not fill, making it difficult to visualize. Stones that lack calcium and cannot be seen may be outlined by the dye. These are called negative shadows. For the test to be completed the patient is given a fatty meal. This causes a stimulation of the flow of bile and the gall bladder will empty if it is normal. If the gall bladder is diseased, it is slow to empty.

Urinary Tract (Urography).—To obtain good x-ray films of the urinary tract it is necessary to remove all substances (gas and feces) from the gastrointestinal tract that might produce confusing shadows. This is done by giving the patient castor oil the night before the examination and a cleansing enema one hour before the x-rays are to be taken the following morning. To outline the kidneys, an opaque dye (*Diodrast*) may be injected intravenously (*intravenous pyelography*), or it may be injected from below through the urethra by means of catheters in the ureters (*retrograde pyelography*). Prior to the injection of the dye a flat film of the abdomen is taken to determine the presence of stones Failure of the kidneys to fill with dye given by the intravenous method indicates poor function of the kidneys Visualization of only one kidney indicates either absence of the other kidney or that it is diseased and does not function. By this method it is possible to diagnose such diseases as polycystic kidneys, renal tumors, kidney stones, and hydronephrosis.

peritoneum and other abdominal organs. This examination is of great value in obtaining biopsy specimens and in making a diagnosis without doing an exploratory laparotomy.



reproduced showing the three unipolar limb leads (AVR, etc.), V_2, etc). The P waves and the ' waves are upright in all leads.

Electrocardiography.—This is a special method of recording electrical currents in the heart muscle just before and during each mechanical contraction of the heart. The machine used *is called an electrocardiograph. The record obtained is called* an electrocardiogram. In the field of diagnosis the electrocardiogram is used to confirm and aid in the diagnosis of disease of the heart rather than to make the diagnosi use is in determining irregularities of the hea auricular fibrillation, and to diagnose and lo infarctions

helpful in peptic ulcer and cancer of the stomach for x-ray ethods will establish a correct diagnosis in most cases. It is of ilue in determining the existence of pathology in the stomach patients complaining of vague gastrointestinal symptoms.

Proctoscopy and Sigmoidoscopy (Proctosigmoidoscopy).—iis is an important examination in the study of patients comaining of symptoms that are suggestive of disease of the large testine. A straight metal tube is inserted into the rectum id passed forward into the sigmoid, allowing for inspection the mucosa This examination is of great value in differenting between benign and malignant lesions of the rectum id sigmoid. It enables the doctor to take a biopsy which is e only positive method of making the diagnosis. Direct vislization of ulcers on the mucosa helps in making a diagnosis such diseases as amebic dysentery, bacillary dysentery, berculosis, and ulcerative colitis.

Bronchoscopy.—By introducing a straight metal tube called e bronchoscope into the trachea, it is possible to study the ucosal lining of the trachea and the larger bronchi. Its ost important use is in removing foreign bodies causing struction of the trachea or bronchial tree It is the only ethod by which a biopsy can be obtained from the bronchial e for making a diagnosis of cancer for many malignant nors may originate in a bronchus. Removal of pus that has rmed behind an obstructing foreign body or lesion of the onchus has been made possible with the bronchoscope. pirating the bronchial tree to remove pus is now a common actice in patients suffering from bronchiectases.

Cystoscopy.—This is performed with an instrument (cystope) that is passed through the urethra into the bladder permits visualization of the urinary bladder and the openzs of the two ureters. It also is used to perform operations bladder tumors and the prostate gland. In inflammation the bladder (cystitis) the mucosa is red and edematous with perficial ulcers Tumors of the bladder may be malignant benign, and a biopsy is made possible by the cystoscope

Peritoneoscopy.—To insert the peritoneoscope into the perineal cavity, it is necessary to make a small incision through e abdominal wall. This makes it possible to visualize the

To obtain a record of the electrical waves set up in the heart it is necessary to attach to the arms and legs of the patient wire leads (electrodes) that connect him to the electrocardiograph. With these connections attached in different ways on the arms and legs of the patient the machine is able to record the electric current produced by the heart and record it on a strip of paper.

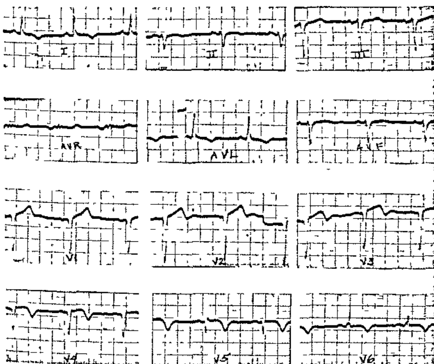
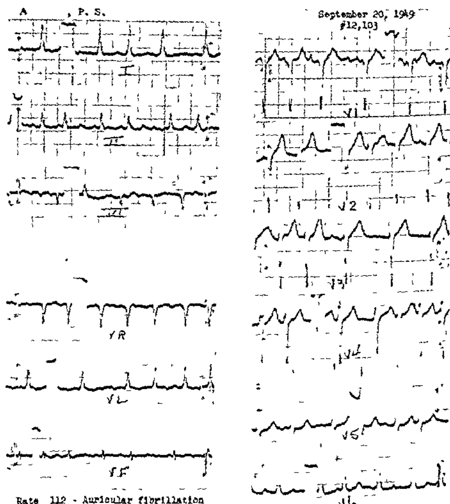


Fig. 59.—Extensive anterior infarction Note the inverted T wave in L I, L II, AVR, and V leads, upright T wave in L III, AVR, V_1, V_2, V_3, and the deep Q wave and elevated S-T segments in the V leads

Electroencephalography.—The brain, like the heart, produces electrical currents when it is in action. The machine used to record these brain waves is called an electroencephalograph. The record made is called an electroencephalogram To pick up these brain waves pieces of metal (electrodes) are attached to different points on the patient's scalp. These in turn are joined together by fine strips of wire



Rate 112 - Auricular fibrillation
The QRS complexes are slurred and monophasic, upright in leads I and II, inverted in III. The T waves are indeterminate. The V limb leads show the heart to be in the semi-transverse position. The T waves are indeterminate. In the V leads, the R waves appear in V2, become taller to V5, slightly lower in 6. The T waves are upright from V1 to 5, indeterminate in V6 with some ST depression. IMPRESSION: Auricular fibrillation and the general appearance of the QRS complexes suggest myocardial damage of indeterminate nature.

Fig 58.—Auricular fibrillation showing the irregular rhythm and fibrillation waves, and the absence of P waves

Friedman's test is based on the fact that the urine of pregnant women contains a hormone which is similar to that produced by the anterior pituitary gland. This hormone is called the anterior pituitary-like hormone (A. P. L. hormone). During pregnancy the urine contains an excess amount of the hormone. The presence of this hormone is detected by injecting a fresh morning specimen of urine with a specific gravity of not less than 1.017 into the ear vein of a virgin female rabbit. The injection is repeated at the end of twenty-four hours After forty-eight hours from the first injection, the rabbit is killed and the ovaries examined for the formation of corpora hemorrhagica. These are blue-red hemorrhagic areas that appear on the ovaries if the test is positive. If the test is negative, hemorrhagic areas do not appear.

This test is accurate in 98 per cent of the cases Pregnancy can be diagnosed as early as two weeks after conception. Ectopic pregnancy will give positive reactions in about ½ per cent of the cases Other conditions giving positive reactions are hydatidiform mole and chorioepithelioma Negative reactions occur in the absence of pregnancy, pregnancy with death of the fetus, missed abortions, and ectopic pregnancies after death of the placental tissue.

In normal individuals the brain waves appear on the electroencephalogram (E.E.G.) as wavy lines. These lines show three patterns: alpha, beta, and mixed rhythms. These waves are measured by their frequency and amplitude. The frequency and amplitude in normal persons may vary according to their physiological state. For example, during sleep the brain waves undergo changes that might be considered pathological in an individual who is awake.

Electroencephalography is frequently used to aid in the diagnosis of conditions that produce abnormal brain waves. These may appear in epilepsy, brain tumors and abscesses, and intracranial hemorrhage.

Basal Metabolism Test.—The basal metabolic rate (B.M.R.) is the term used to designate the amount of heat produced by an individual who is at complete rest twelve to fourteen hours after eating a light meal. It is necessary that the patient be in a fasting state and free from all mental excitement or physical exertion. The basal metabolic rate is obtained by having the patient breathe into a special apparatus for ten minutes and then measuring the amount of oxygen consumed during that time. The test should always be done in the morning before breakfast and after the patient has had a night's rest. It is best to have the patient spend the preceding night in the hospital, but since this is not always possible, the patient must be allowed to rest one-half to one hour before the test is performed. Any physical exertion or mental excitement just prior to the test will cause the metabolic rate to go up It is a common practice to make several tests to allow the patient to become accustomed to the apparatus This ensures a metabolic rate that is at basal level.

The normal basal metabolic rate varies between −10 and +10 The test is most frequently used to determine the activity of the thyroid gland. The basal metabolic rate is increased in hyperthyroidism, hyperpituitarism, diabetes, leukemias, and acidosis. It is decreased in hypothyroidism, hypopituitarism, and starvation.

Pregnancy Tests.—There are several tests for pregnancy but it is necessary to mention only the one that is most commonly used—Friedman's test This is a modification of the original Aschheim-Zondek test which was performed on mice instead of rabbits.

TABLE I. URINALYSIS—ROUTINE—CONT'D

	NORMAL	PATHOLOGICAL SIGNIFICANCE
Twenty-four hour specimens		
(Quantitative tests are of value only on 24 hour samples)		
Collection:		
1. The patient should be instructed to empty the bladder at the beginning of the period (8 A.M.) and discard the urine.		
2. Save all urine passed until 8 A.M. the next morning, emptying the bladder at that time and adding this urine to the 24 hour specimen.		
3 It is sometimes desirable to have the day and night specimens examined separately. a Day specimen—Obtain as for the 24 hour specimen, including specimen voided 3 hours after the evening meal b. Night specimen—Save all urine voided during the night and empty bladder at 8 A.M., adding this to the night specimen		
4 If amount is important, the patient [illegible] sufficient.	Amount 800-1600 cc varies [illegible] liquid [illegible] rspira- [illegible] ., 500-1500 cc Children 1-6 yr, 300-1000 cc The day volume is 3-4 times the night volume.	Amount: Increased quantity (polyuria) is found in diabetes mellitus and insipidus, chronic nephritis, certain nervous diseases, during disappearance of an edema, and during convalescence from an acute febrile disease. Decreased quantity (oliguria) is found
5 The urine should be kept in a clean receptacle and in a cool place.		

OUTLINE OF THE MORE COMMON LABORATORY EXAMINATIONS—UNIT IV

Tables I-X are for quick reference only and should be studied along with the detailed descriptions already presented.

TABLE I. URINALYSIS—ROUTINE

	NORMAL	PATHOLOGICAL SIGNIFICANCE
Single specimens Important points in collection: 1. If only a qualitative	Color: Straw to amber. Colorless to straw. Amber. color- lowing on of ds and	Color: Reddish-amber may indicate an increase in urobilinogen or porphyrin. Brownish-yellow or green with yellow foam when shaken indicates bile pigments.
2. Urine passed about 3 hours after a meal is most likely to contain pathological substances. 3. First urine voided in the morning is least likely to contain pathological substances 4. To diagnose cyclic albuminuria, samples obtained at various intervals during the 24 hours must be examined	Red—Beets, Mercurochrome or Prontosil instillations, phenolphthalein, selenium. Blue or green—Methylene blue. Brown—Rhubarb, senna, cascara, argyrol instillation. Yellow — Carotene, santonin or pyridium. Green—Acriflavine.	Red to smoky brown may be due to blood pigment. Milky may be due to large amounts of pus, bacteria, fat, or chyle. Brownish-black may indicate melanin which may appear only after the urine stands and chromogen melanogen is converted into melanin If present, a gray precipitate which blackens on standing forms when a few drops of 10% ferric chloride is added to 10 cc of urine.
Bacteriological examinations 1. The urine must be a fresh catheterized specimen obtained under aseptic conditions. 2. If cultures cannot be made immediately, the specimen should be placed in the ice box.		Black may indicate homogentisic acid which occurs in alkaptonuria. Urine becomes black after standing or after it is alkalized. Homogentisic acid reduces Benedict's solution.

TABLE I URINALYSIS—ROUTINE—CONT'D

	NORMAL	PATHOLOGICAL SIGNIFICANCE
above or deducted for each 3°C below 5. If the quantity of urine is small, and the specific gravity is important, the urine may be diluted with distilled water and the specific gravity read, to obtain the correct number, multiply the last two figures of the specific gravity number by the amount of dilution. This diluted urine cannot be used for qualitative or quantitative tests.	action, the pH ranging from 4.8 to 7.0, with an average of 6. 2. It may be alkaline after a full meal, after taking large quantities of citrus fruits, or as a result of taking alkalies 3. Twenty-four hour specimens are less acid than freshly passed specimens and may become alkaline after standing due to the decomposition of urea by bacteria and the liberation of ammonia Reaction is obtained by the use of nitrazine paper. Litmus paper test. a Pink color—Acid b. No change—Neutral c *Blue—Alkaline.*	sis, fevers, and a diet with an excess of protein. 2. May be alkaline in chronic cystitis and urine retention due to decomposition of the urine in the bladder (The decomposition of urea by bacteria and the liberation of ammonia.) 3 Fixed alkaline urines are associated with anemia, rapid absorption of transudates, some nervous diseases, obstructing gastric ulcer, severe vomiting, and alkaline therapy.
Cloudiness Cloudiness is reported as· + + + + + + + + + +	Freshly voided urine is usually clear It may be cloudy normal resulting from 1 Amorphous phosphates form a white cloud or precipitate in neutral or alkaline urine but the cloud disappears upon addition of dilute acetic acid 2 Amorphous urates form a white or *pink cloud of sediment* (brick dust deposit) in acid urine which disappears on heating 3 Epithelial cells, mucus, and leuko-	Cloudiness Cloudiness may be caused by the following substances· 1. Epithelial cells and mucus give cloudiness to urine when present in large amounts 2. Blood gives urine a red or brown, smoky color. 3 Pus makes urine turbid but clears *up on filtering or* centrifuging. 4 Bacteria produces a uniform cloudiness which does not settle out and cannot be filtered out

TABLE I. URINALYSIS—ROUTINE—CONT'D

	NORMAL	PATHOLOGICAL SIGNIFICANCE
		in uremia, acute nephritis, eclampsia, severe diarrhea, excessive vomiting, profuse sweating in fevers, cardiac decompensation, calculus or tumor of the kidney, nephrosis with edema, atrophic hepatic cirrhosis, and acute yellow atrophy of the liver. Total suppression (anuria) occurs in "collapse" with systolic blood pressure below 70 mm of mercury, severe acute nephritis, and in poisoning with bichloride of mercury Residual urine is that obtained by catheter immediately after the patient has emptied the bladder voluntarily.
iods used for specific ravity 'ill container ¾ full f urine and remove ll foam loat urinometer in rine by rotating it apidly to prevent it uching the sides or ottom of the conuner. ead the graduation i the stem of the istrument at the vel of lower part of ie numbers. the temperature of e urine is above or slow 25°C. a correcve .001 must be lded for each 3°C	*Specific gravity*. A 24 hour specimen *may range from* 1015-1025. It varies inversely with the volume and directly with the amount of salt, urea, and protein in solution For each gram of albumin per 100 cc of urine, the specific gravity is increased 0 030 *Single specimens may range from* 1 002-1 030.	*Specific gravity* 1. Varies from 1.001-1 060. 2. Low in chronic nephritis and diabetes insipidus 3. High in diabetes mellitus, fevers, *and acute nephritis.*
	Reaction: 1. Freshly voided urine is acid in re-	Reaction: 1 Acidity is increased in acido-

TABLE I. URINALYSIS—ROUTINE—CONT'D

	NORMAL	PATHOLOGICAL SIGNIFICANCE
above or deducted for each 3°C. below. 5. If the quantity of *urine is small*, and the specific gravity is important, the urine may be diluted with distilled water and the specific gravity read, to obtain the correct number, multiply the last two figures of the specific gravity number by the amount of dilution. This diluted urine cannot be used for qualitative or quantitative tests.	action, the pH ranging from 4.8 to 7.0, with an *average of 6.* 2. It may be alkaline after a full meal, after taking large quantities of citrus fruits, or as a result of taking alkalies. 3. *Twenty-four hour* specimens are less acid than freshly passed specimens and may become alkaline after standing due to the decomposition of urea by bacteria and the liberation of ammonia. Reaction is obtained by the use of nitrazine paper. Litmus paper test a. Pink color—Acid. b. No change—Neutral. c. Blue—Alkaline	sis, fevers, and a diet with an excess of protein. 2. *May be alkaline in* chronic cystitis and urine retention due to decomposition of the urine in the bladder. (The decomposition of urea by bacteria and the liberation of ammonia.) 3. Fixed alkaline urines are associated with anemia, rapid absorption of transudates, some nervous diseases, obstructing gastric ulcer, severe vomiting, and alkaline therapy.
Cloudiness Cloudiness is reported as. + + + + + + + + + +	Freshly voided urine is usually clear. It may be cloudy normal resulting from 1. Amorphous phosphates form a white cloud or precipitate in neutral or alkaline urine but the cloud disappears upon addition of dilute acetic acid. 2. *Amorphous urates* form a white or pink cloud of sediment (brick dust deposit) in acid urine which disappears on heating. 3. Epithelial cells, *mucus, and leuko-*	Cloudiness Cloudiness may be caused by the following substances: 1. *Epithelial cells and* mucus give cloudiness to urine when present in large amounts 2. Blood gives urine a red or brown, smoky color 3. Pus makes urine turbid but clears up on filtering or centrifuging. 4. Bacteria produces a uniform cloudiness which does not settle out and cannot be filtered out.

TABLE I. URINALYSIS—ROUTINE—CONT'D

	NORMAL	PATHOLOGICAL SIGNIFICANCE
	cytes form a faint cloud with cooling. 4. Contaminating bacteria produce an alkaline urine causing precipitation of alkaline salts.	5. Fat and chyle may render urine turbid. 6. Shreds are often present in chronic gonorrhea.
	Odor: 1. Aromatic due to volatile acids, more marked in concentrated urine 2. Various articles of diet and drugs impart peculiar odors, especially asparagus and turpentine.	Odor: 1. It is ammoniacal after decomposition. Important only in fresh urine and found in cystitis and urine retention. 2. It is fruity in diabetes if ketone bodies are present.

TABLE II. CHEMICAL TESTS ON URINE

TEST	COMMENT	PATHOLOGICAL SIGNIFICANCE
I. Protein A. Albumin *Qualitative Tests* 1. Robert's test (use of Robert's reagent)	Principle: All methods depend *upon the precipitation* of protein by chemical agents or by coagulation by heat. A qualitative test determines the nature of the elements in the specimen (urine).	Albumin in the urine is derived from a *number of* sources: 1. Physiological *albuminuria* appears after excessive muscular exertion, prolonged cold baths, excessive ingestion of proteins. 2. Orthostatic or postural albuminuria ap*pears after a* person has been in an erect position and disappears with rest in bed.
Saturated magnesium sulfate solution U.S.P. . . . 5 parts Nitric acid (conc.) . . . . 1 part		
A positive test is indicated by a white ring where the reagent comes in contact with the urine in the test tube.		
2. Sulfosalicylic acid test (Exton's method)	If no ring or cloudiness, albumin is absent.	3 Accidental or false albuminuria may be due to· a. Pus, blood, or vaginal discharge b Found in pyelitis, cystitis, and *chronic vaginitis.*
Exton's qualitative reagent: Sodium sulfate (anhydrous) 50 Gm. Sulfosalicylic acid 50 Gm. Distilled water to make 1 liter. Equal volumes of the urine and the reagent are mixed in a test tube. Bence-Jones *protein* causes a heavy precipitate which *clears partially or* wholly on boiling.		
3. Heat and acetic acid tests If the urine when heated in a test tube shows turbidity, then albumin is present unless the white cloud can be dispelled by adding 3 drops of 10% acetic acid.		*Pathological albuminuria.* a. Albumin in kidney disease is derived from blood plasma and indicates increased permeability of the glomerular filter.

TABLE II. CHEMICAL TESTS ON URINE—CONT'D

TEST	COMMENT	PATHOLOGICAL SIGNIFICANCE
4. *Purdy's test* To the urine is added ⅙ of its volume of saturated aqueous solution of sodium chloride to raise the specific gravity (high specific gravity prevents precipitation of mucin). To this is added 2-5 drops of glacial acetic acid. The upper portion of this is boiled gently. A cloud denotes the pressure of albumin		Albumin, because of its smaller molecule, is excreted in larger amounts than globulin or fibrin, markedly decreasing the albumin-globulin ratio in blood plasma when the albuminuria is of a severe grade. b. Also present in febrile diseases, toxemia of pregnancy, passive congestion of the kidneys, and anemias
Quantitative tests	Quantitative tests are used for determining the amount of the element present in a given quantity of the specimen (urine).	
1. Esbach's test Powdered pumice or barium is added to the urine to increase the rate of sedimentation; after the reagent is added, the tube is set in a rack in a cool place for sedimentation. The reading on the tube indicates grams of albumin per liter *of urine To change* to per cent, divide by 10.		
2. Life insurance method *Sulfosalicylic acid*, 7.5 cc of 10% is added to 2.5 cc of clear urine in a test tube, inverted 3 times, and allowed to stand 3 minutes. Turbidity is matched with permanent standards.		

TABLE II. CHEMICAL TESTS ON URINE—CONT'D

TEST	COMMENT	PATHOLOGICAL SIGNIFICANCE
II. Bence-Jones protein To test for this substance, the urine is heated in a test tube which is placed inside a beaker of water with a thermometer placed in the beaker. At about 40°C. the urine will begin to be turbid and a precipitate will form at about 60°C. Ten per cent acetic acid is added to acidify the urine slightly. The precipitate wholly or partly dissolves at boiling point. It is filtered while hot. The Bence-Jones protein reappears on cooling to 60°C. The test may be confirmed by adding nitric acid to precipitate the protein. The precipitate wholly or partially clears up on boiling and reappears on cooling. It should be filtered immediately after boiling if albumin is present.	Thought to be a proteose and is usually associated with high serum globulin.	Found in 50% of patients with multiple myeloma, chronic leukemia, empyema and hyperparathyroidism. It is found along with albumin in some cases of chronic nephritis with high blood pressure and edema, also, in some apparently healthy young people with high blood pressure
III. Glucose If albumin is present, it must be removed before the tests for glucose are made. The presence of albumin interferes with the sugar reactions. When sugar is found, always test for acetone and diacetic acid. False positive tests may be	Normally present in 0.01 to 0.03 Gm. per 100 cc of urine	In diabetes mellitus sugar usually appears in the urine when the level of glucose in the blood rises above 160 mg. per 100 cc. This is the renal threshold (varies from 114-216 mg. for glucose for most people). In renal diabetes, glucose appears in the urine with normal

TABLE II. CHEMICAL TESTS ON URINE—CONT'D

TEST	COMMENT	PATHOLOGICAL SIGNIFICANCE
due to homogentisic acid in alkaptonuria. Increased ascorbic acid after anesthesia: formalin used as a preservative; also glucuronates from camphor, chloral hydrate, or morphine and urates reduce copper slightly.		or low blood levels. Glycosuria may be present after brain injury and after coronary thrombosis.
Qualitative test 1. Benedict's test	Principle: An alkaline copper sulfate reagent is reduced to cu- [illegible] oxide by the [illegible] of glucose [illegible]her reducing [illegible], a small quantity (up to 0.5%) of reducing substances are present which appear as a slight yellow precipitate only when the reagent is cold.	In the presence of glucose, the entire solution will be filled with a precipitate ranging in color from yellowish-green to red.
[illegible] Sodium citrate c.p. 173.0 Gm. Sodium carbonate (anhydrous) . . . . 100 Gm. Distilled water to make 1 liter.		
In this test a few drops of urine are added to 5 cc of Benedict's solution in a test tube and boiled vigorously The reaction is read by the amount of sediment after the tube cools slowly		

None	−	Clear blue to cloudy green
.5 Gm %	+	Yellowish-green
1-1.5 Gm. %	++	Greenish-yellow
1 5-2.5 Gm %	+++	Yellow
2.5-4 Gm %	++++	Orange
4+ Gm. %	+++++	Red

TABLE II. CHEMICAL TESTS ON URINE—CONT'D

TEST	COMMENT	PATHOLOGICAL SIGNIFICANCE
Quantitative Tests		
1. Benedict's method	*Principle:*	
Benedict's quantitative reagent: Copper sulfate (pure crystallized) 18.0 Gm. Sodium carbonate (anhydrous) 100 Gm. Sodium citrate c.p. 200 Gm. Potassium ferrocyanide sol. 5% Potassium sulfocyanate c.p 125 Gm. Distilled water to make 1 liter	*Glucose* (and other reducing substances) reduce the copper hydroxide to cuprous oxide which in the presence of potassium thiocyanate is changed to white copper thiocyanate. The *amount of glucose* in the urine is obtained by quantitative tests.	
The Benedict's quantitative reagent is placed in an evaporating dish. Sodium sulfocyanide, pumice, and talcum are added, then heated, and the urine added during the boiling. The urine is added rap*idly* until the mixture forms a chalk white precipitate, then drop by drop, until the mixture is green. The calculation is made by measuring quantity of urine used since the Benedict's solution is of such strength that 25 cc are reduced by 0.05 Gm of glucose 1. The percentage is obtained by dividing 5 (0.05 × 100) by the number of		

TABLE II. CHEMICAL TESTS ON URINE—CONT'D

TEST	COMMENT	PATHOLOGICAL SIGNIFICANCE
cubic centimeters of urine required to reduce 25 cc of Benedict's solution. 2. To obtain the grams in 24 hours, divide 0.05 by the amount of urine needed to reduce 25 cc of Benedict's solution and multiply by the number of cubic centimeters of urine in the 24 hour specimen 2. Benedict's test tube method 5 cc of Benedict's quantitative reagent are placed in a large Pyrex test tube One to two grams of sodium carbonate are added and the mixture boiled vigorously Then urine is added drop by drop until the blue color begins to fade The solution should then be boiled for 30 seconds between the addition of each drop The end point is reached when the blue just disappears and a gray color remains Calculation. 1. The number of cubic centimeters of urine used divided into 1 (0.01 × 100) equals the glucose present in per cent since 0.01 Gm. of glucose reduces 5 cc of Benedict's reagent.		

TABLE II. CHEMICAL TESTS ON URINE—CONT'D

TEST	COMMENT	PATHOLOGICAL SIGNIFICANCE
2. For grams per 24 hours, divide cubic centimeters of urine into the total volume of urine and divide by 100.		
IV. *Ketone bodies*—tests	*Ketone bodies are acetone, diacetic acid, and beta hydroxybutyric acid*	*Faulty* catabolism of fats whereby the fatty acids are not completely oxidized. When these are present in the urine, there is a state of ketosis. Ketosis occurs most frequently in diabetes *mellitus* but is also found in starvation, von Gierke's disease, eclampsia, fevers, certain nervous disorders, after prolonged vomiting or diarrhea, and after ether or chloroform anesthesia.
1. Rothera's test (for acetone and diacetic acid)		
1 Gm. ammonium sulfate crystals is added to fresh urine, 5 cc, overlaid with ammonium hydroxide. If acetone is *present, a red to* purple color will form at the line of contact	Fresh urine contains very little acetone but on standing the diacetic acid is decomposed into acetone.	
2 Gerhardt's test for diacetic acid	Specimens positive for sugar and all specimens from prenatal patients and patients in acidosis should be examined routinely for acetone and diacetic acid	
10% ferric chloride is added drop by *drop until all the* phosphates are precipitated. If a red color appears, the test is repeated An equal volume of water and urine with 1 drop of nitric acid added is boiled and, *when cool, ferric* chloride is added If there is no red color this time, the test is positive for diacetic acid		
V *Bile Pigment*	Bilirubin is not normally found in the urine but may be demonstrated in some cases when there is no visible jaundice of the *skin or sclera.*	1 In complete obstructive jaundice there is bilirubin without urobilinogen in the urine. 2. In partial obstruction and hepatogenous *jaundice,*
1 Gmelin's test		
Barium chloride is added to urine and allowed to stand. *It is then filtered*		

TABLE II. CHEMICAL TESTS ON URINE—CONT'D

TEST	COMMENT	PATHOLOGICAL SIGNIFICANCE
through a small filter paper. Yellow nitric acid is dropped in the center of the paper. A positive reaction is indicated by a play of colors (green, blue, violet, and yellow).		both bilirubin and bilinogen may be found in the urine. 3. In hemolytic jaundice urobilinogen is present but no bilirubin unless there is liver damage.
2. Foam test 1. Shake urine; if foam on top is yellow, bile may be present 2 Certain drugs (Pyridium, Serenium) and increased amounts of urobilin compounds will give a false positive test.		
VI. Urobilinogen 1 Ehrlich's test Ehrlich's reagent 1 cc is added to 10 cc of urine and allowed to stand 5 minutes A cherry red color appears if urobilinogen is present in excessive amounts	Urobilinogen is formed in the intestine by the action of bacteria on bile pigment. Part is excreted in the feces, part absorbed by the intestine and returned to the liver by way of the portal vein to be reconverted into bilirubin, and a small amount normally passes through the liver and is excreted by the kidney.	In complete obstruction of the bile ducts, no urobilinogen will be formed and none will be found in the urine. In all conditions with excessive destruction of erythrocytes there will be an increase of bile pigment in the intestine, resulting in an increased formation and absorption of urobilinogen. The liver is unable to convert all of this into bile, so there is an increased excretion of urobilinogen in the urine.
Ehrlich's reagent-modified: Distilled water 100 cc Hydrochloric acid (conc.) . . . .150 cc P-dimethylaminobenzaldehyde 0 7 Gm		

TABLE II. CHEMICAL TESTS ON URINE—CONT'D

TEST	COMMENT	PATHOLOGICAL SIGNIFICANCE
2. Quantitative urobilinogen test Use 24 hour specimen. Collect urine in a brown bottle containing 100 cc of benzine and 5 Gm. of anhydrous sodium carbonate.		In partial damage to the parenchyma of the liver, there is an increase of this in the urine. A temporary increase of urobilinogen in the urine may be due to constipation.
VII. Blood Blood may be in the form of intact erythrocytes (hematuria) or hemoglobin hemoglobinuria.	Principle: The peroxidase activity of hemoglobin decomposes hydrogen peroxide and the liberated oxygen oxidizes the benzidine.	See discussion in text, p. 238.
1. Test Benzidine labeled for blood test must be used.		
Benzidine test One (1) gram of benzidine is placed in a test tube and 3 cc of glacial acetic acid are added. Allow to settle and pour off the liquid into another clean test tube. 2 cc of urine are boiled, cooled, then added and mixed.		
1 cc of fresh hydrogen of peroxide is then added. The appearance of a green or blue color within 5 minutes indicates blood.		
Report Trace, faint green; +, green, ++, greenish-blue, +++, blue, ++++, deep blue.		

TABLE III. ANALYSIS OF URINARY CALCULI

CHEMICAL GROUP	REAGENTS ADDED	RESULT
1. Urates and uric acid	Pulverized stone 1 drop 20% Na_2CO_3 2 drops uric acid reagent	Prompt deep b color (pale blu negative)
2. Phosphates	Pulverized stone 4-5 drops ammonium molybdate solution (need excess of reagent)	Warm over flame get distinct yell precipitate (NH PO₄12MoO₃)
3. Oxalates	Pulverized stone 2-3 drops HCl; if no effervescence, cool and add a pinch of MnO_2, do not mix	Tiny bubbles of g "explosively" r leased from t bottom
4 Carbonates	Relatively large sample of pulverized stone 8-10 drops 10 % HCl	Foaming effervescence

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on by a projecting wis
, 6, 7.

CHEMICAL GROUP	REAGENTS ADDED	RESULT
5. Calcium *	Acid extract 2-3 drops 20% NaOH	Fine white precipitat or film from oxalate stones; precipitate from phosphate stones
6. Magnesium *	Acid extract 2-3 drops 20% NaOH 2-3 drops reagent "M"	Reddish-purple reagent slowly becomes definitely blue (precipitate forms)
7. NH_4 group *	Acid extract 2-3 drops 20% NaOH 2-3 drops Nessler's solution Alternative Pulverized stone and 2-3 drops Nessler's solution	Yellowish-orange precipitate
8. Sulfonamides *	Pulverized stone 2 drops 10% HCl (wait 30 seconds) 2 drops $NaNO_2$ (wait 30-60 seconds) 2 drops 0 5% ammonium sulfanate 2-3 drops reagent S	Brownish-pink to magenta
9. Cystine *	Pulverized stone 1 drop NH_4OH, 1 drop NaCN (wait 5 minutes) 2-3 drops sodium nitroprusside)	Beet red color, on standing, may fade to orange-red

* Use a microscope for these tests; use spot plate for the others The artist's type is more satisfactory than the regular chemist's spot plate.

TABLE IV. KIDNEY FUNCTION TESTS

NAME OF TEST	NORMAL	PATHOLOGICA SIGNIFICANC
Concentration diuresis test 1. No extra fluids with evening meal (only 1 glass water) which should be high in protein 2. No fluids or food until after test 3. Save first specimen urine and send to laboratory 4. Give patient 1,500 cc water in next ½ hour 5. Collect specimen 1, 2, 3, and 4 hours from time patient took water	1. First morning specimen should be concentrated to specific gravity of 1.022 or over 2. First hour specimen after water should have specific gravity of 1.001-1.003 3. After drinking water, every hourly specimen should have specific gravity of 1.001 to 1.003 and volume of 400 cc 4. Each hour the volume is less with increase of specific gravity 5. At fourth hour the specific gravity should be 1.012-1.016, with volume of 100 cc	1. Inability of ki to excrete uri specific gravi 1.022 or highe dence of dam
Mosenthal test 1. Patient voids at 8 A.M. and specimen discarded 2. Collect urine specimens at 10 A.M., 12 N., 2 P.M., 4 P.M., 6 P.M. and total voided 8 P.M. to 8 A.M.	1. Day specimens' specific gravity vary by 9 points or more. 2. Night specimen specific gravity not lower than 1.018 and should not exceed 575 cc in volume	1. Nocturnal pol is one of first dences of imp kidney func volume of n urine exceeds cc
Phenolsulphonphthalein test (P.S.P.) This test is primarily for tubular function	1. 40 to 60% in first hour, after second hour, 45 to 75%, after intra muscular injection, appears in urine 5-11 minutes, after 70 minutes, 40-60%, after 2 hours and 10 minutes, 60-75%	1. In severe ki damage the is diminished

TABLE V. BLOOD

NAME OF TEST	NORMAL		PATHOLOGICAL SIGNIFICANCE
Hemoglobin	80-100% (12-16 Gm. %) for women; 90-110% (14-18 Gm. %) for men		Decrease in hemoglobin in anemias, malaria, lead poisoning, arthritis, leukemia, cancer, etc. Increase in hemoglobin in polycythemia, hemoconcentration, cardiac disease
Red cell count			nancy, erythroblastic), lead poisoning, jaundice
Color index	.85-1.0		Low in hemorrhagic and iron deficiency anemias High in pernicious anemia
Red cell volume			
White blood cell count			Decrease in aplastic anemia, aleukemic leukemia, and agranulocytosis
Differential white cell count	Myeloblasts	0	Present in myelogenous leukemia
	Myelocytes	0	Present in myelogenous leukemia
	Monocytes	3-10%	Increase in infectious mononucleosis and whooping cough
	Basophiles	.5-1%	Increase in allergy
	Eosinophiles	2-4%	Increase in allergy
	Neutrophiles	55-70%	Increase in infections
	Lymphocytes	20-30%	Increase in lymphocytic leukemia, infectious mononucleosis, and whooping cough
	Stabs	3-5%	Increase in acute bacterial infections and chronic myeloid leukemia

TABLE V. BLOOD—CONT'D

NAME OF TEST	NORMAL	PATHOLOGICAL SIGNIFICANCE
Blood platelets (thrombocytes)	250,000 to 300,000 per cubic millimeter	High in infections after incubation period and in chronic myeloid leukemia Low after trauma, uremia, severe infections, aplastic anemia, hemorrhage
Bleeding time	2-3 minutes	Prolonged bleeding time as result of toxins, malnutritions, purpura, sepsis
Coagulation time	4-6 minutes	Prolonged in purpura, acute leukemia, aplastic anemia, some severe infections
Sedimentation rate (Westergren method)	After 1 hour 1-10 mm for men 1-15 mm for women	Increased in infections, inflammatory conditions, most blood diseases, infectious arthritis, organic diseases of the G I tract, myocardial infarction, etc Delayed rate in allergy, acidosis, some cardiac conditions, cirrhosis of liver
Prothrombin time	Prothrombin clotting time, 22-25 seconds Prothrombin, 80-100%	Increased in obstructive jaundice Decreased after dicumarol treatment and in obstructive jaundice
Red cell fragility	Hemolysis begins at 0.44 to 0.42% *sodium chloride* solution, complete in that containing 0.34%	Fragility increased in hemolytic jaundice Decreased in chronic obstructive jaundice
Capillary fragility test		
Heterophile antibody test (Paul-Bunnell)		High in acute mononucleosis

TABLE VI. BLOOD GROUPS

NAME OF TEST	NORMAL	PATHOLOGICAL SIGNIFICANCE
Typing — To determine type of blood before transfusion	(According to Landsteiner) O (IV), 45% of people A (II), 42% of people B (III), 10% of people AB (I), 3% of people	Necessary to know before transfusion
	Rh positive, 85% of people Rh negative, 15% of people	Important in pregnancy and certain conditions of newborn; also in persons receiving repeated transfusions

TABLE VII GASTRIC ANALYSIS

NAME OF TEST	NORMAL	PATHOLOGICAL SIGNIFICANCE
Free hydrochloride	Fasting, 5-20 degrees, after test meal, without histamine, 25 to 50 degrees; with histamine, 50 to 70 degrees	High when ulcer is present Low with gastric carcinoma Absent in pernicious anemia
Total acidity	Fasting, 15-45 degrees, after test meal, without histamine, 40-65 degrees, with histamine, 65-90 degrees	

TABLE VIII. EXAMINATION OF SPINAL FLUID

NAME OF TEST		PATHOLOGICAL
Color and appearance	Clear (lik … be slightly blood-tinged from needle insertion	meningitis, bloody or yellow in central nervous system hemorrhage
Pressure	Adults, 100 to 200 mm water—patient lying down Adults, 200 to 300 mm. water—patient sitting Children, 50-100 mm. water—patient lying down	Increased in meningitis, edema of brain, hemorrhage and neurosyphilis Decreased in shock, dehydration, and spinal canal block
Cell count	1-10 per cubic millimeter (lymphocytes)	Increased in various types of meningitis, poliomyelitis, neurosyphilis, and encephalitis; pus cells predominate in acute bacterial infections; lymphocytes found in tuberculous meningitis, poliomyelitis, and neurosyphilis
Protein	15-45 mg per 100 cc	Increased in conditions with increased cell count, spinal cord tumor, caries of spine, and infectious polyneuritis
Lange's colloidal gold test	0001100000	5554321000, paretic type curve 0244310000, luetic or tabetic type curve 0000245520, meningitis type curve
Sugar	*45-70 mg per 100 cc*	*Increased in diabetes,* epidemic encephalitis, uremia, and sometimes in brain tumor Decreased in acute *meningitis, tuber*culous meningitis, and insulin shock Normal usually in neurosyphilis
Chlorides	720-750 mg. per 100 cc in adults 620-750 mg per 100 cc in children	Definitely low in tuberculosis and meningitis High may be found in uremia

TABLE IX. EXAMINATION OF SPUTUM

VARIETY	CHARACTER	PATHOLOGICAL SIGNIFICANCE
Mucoid	Clear, thin; may be somewhat viscid	Early stages of bronchitis
Mucopurulent	Thick, viscid, greenish color, inoffensive, frothy, may have a sweetish odor	Later stages of bronchitis, phthisis, pneumonia
Purulent	Thick, viscid, yellow, often offensive	Abscess of lung, empyema, advanced phthisis, bronchiectasis
Nummular	Mucopurulent with small, round, semisolid masses which sink in water	Advanced phthisis
Rusty	Mucopurulent, very viscid and gelatinous; rusty tinge	Pneumonia
Prune juice	Dark brown, offensive, often semisolid	Later stages of pneumonia, gangrene of lung, new growth of lung
Red currant jelly	Blood clots resembling currant jelly	New growth in lung
Blood (hemoptysis)	Bright red, frothy, with air bubbles, blood may be in streaks or mixed with sputum, fluid or clotted, or sputum may consist of pure blood	Phthisis (ulceration of a vessel in a cavity), other diseases of the lung (pneumonia, new growth, gangrene, abscess, bronchiectasis), mitral stenosis, aneurysm rupturing into the bronchial tubes
	Black	Due to inhalation of soot or dust, anthracosis due to inhalation of coal dust
	Contains particles of iron and other metals, also alveolar cells	Siderosis
	Contains particles of silica and other stone dusts	Silicosis

For *macroscopic examination* of any portion of the sputum, pour it into a Petri dish to obtain a thin layer. Examine the specimen with the aid of a hand lens, usually a black background is best.

For *microscopic examination* select a portion during the macroscopic examination and place on a slide. Apply a cover and examine with low and high dry objectives.

TABLE X. BASAL METABOLISM

NAME OF TEST	NORMAL	PATHOLOGICAL SIGNIFICANCE
The basal metabolic rate is measured by means of a calorimeter; the heat is produced in large calories The basal metabolism is proportional to the surface area of the body and varies with the age and sex of the individual Oxygen consumption can be used as an index of heat production One liter of oxygen produces a known number of calories when it is completely used in combustion	Normal basal metabolism rate (B.M.R): ± 10% Possible errors: Moist soda lime water in base of machine or in breathing tubes Flutter valve stuck False low B.M.R. may be due to: Oxygen leaking into spirometer through oxygen pit cock Insufficient soda lime, clock running too fast False high B.M.R may be due to. Leaks around nose clip or mouthpiece Leakage around attachment of rubber tubing Clock running too slow Factors influencing B.M.R Age and sex, surface area, athletic training, climate and altitude, sleep	Decreased in: Starvation and under-nutrition Obesity due to pituitary or hypothalamic disorders Hypothyroidism Hypopituitarism Simmonds' disease (40%) Addison's disease (20%) Lipoid nephrosis Shock Arterial hypotension Increased in: Hyperthyroidism (exophthalmic goiter) Fever Diabetes insipidus Cardiorenal disease with dyspnea (+25 to +50%) Leukemia (+20 to +80%) Polycythemia (+10 to +40%) Acromegaly (early stage) Pituitary basophilism (Cushing's disease) Hypercorticoadrenalism Essential hypertension Severe anemia Spine Osteitis deformans (Paget's disease)

STUDY QUESTIONS—UNIT IV

1. Describe the methods used in making a diagnosis.
2. What is the responsibility of the nurse during the physical examination?
3. Discuss the significance of all the items included in the patient's history.
4. What is the responsibility of the nurse in the laboratory diagnosis?
5. Study the laboratory tests (pp. 338-359), compare the normal with the pathological, and understand the significance of any abnormal findings.
6. What is the responsibility of the nurse in your hospital for the following points when diagnostic tests are done: (a) preparation of the patient; (b) preparation of the equipment; (c) assisting during the test; (d) care, collection, and labeling of specimens; (e) aftercare and observation of the patient; (f) aftercare of equipment; (g) charting.

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UNIT V

HOW DISEASE IS TREATED

In this unit, the general principles underlying therapy are presented. Later, as the student works in each clinical area, more specific and detailed information should be mastered—this is intended to lay the foundation. Material already mastered in nursing arts, in materia medica, in bacteriology, and in chemistry must be reviewed and integrated here. The functions of the nurse in the preparation of the patient, in assisting with and at times carrying out the complete treatment must be mastered. A very important responsibility of the nurse in all therapy is the observation of the patient and the accurate and complete reporting and charting of all her observations and patients' reactions.

CHAPTER 28

THERAPEUTICS

GENERAL INTRODUCTION

Therapeutics is the science of treatment of disease. Treatment (therapy) is the method used to cure disease and the management of a disease or diseased patients. Treatment may be classified as follows: It may be empirical, medical, surgical, palliative or symptomatic, prophylactic, rational, specific, or supportive.

Empirical treatment is the use of remedies which experience has shown to be of benefit while a scientific explanation for the

action of the remedy is unknown. This type of treatment was most commonly used in the past when the cause of most diseases and the *physiological action of the remedies* were not understood. However, it is still used today. An example of empirical treatment is the use of gold salts in the treatment of *rheumatoid arthritis.*

Medical treatment is the treatment of internal diseases such as heart disease (myocardial infarction), pneumonia, and diseases of the blood.

Surgical treatment is treatment by actual cutting and removal of the diseased organs; for example, surgical removal of a diseased appendix.

Palliative or symptomatic treatment is for the relief of symptoms and is not directed at the cure of the disease. This type of treatment is most commonly used to give relief for such symptoms as pain, cough, shortness of breath, and fever.

Prophylactic treatment is the use of a remedy or means that protects the patient from an attack of disease to which he has been exposed or will be exposed. This type of treatment is best illustrated by the so-called prophylactic stations used in the Army for soldiers who had exposed themselves to venereal disease. Another form of prophylactic treatment is inoculation against smallpox, typhoid fever, or other diseases to which the patient may become exposed.

Rational treatment is based upon scientific reasoning and knowledge of the disease and of the remedy which is used. This is the type of treatment that is most commonly used today.

Specific treatment is the use of a remedy that has a known curative effect on a certain disease; for example, penicillin and arsenic for syphilis, quinine and Atabrine for malaria, sulfonamides for streptococcal infections, insulin for diabetes, thyroid for myxedema, thiouracil and iodine for hyperthyroidism, iron for *hypochromic anemia, liver extract and vitamin* B_{12} for pernicious anemia, vitamins for vitamin deficiency (rickets and scurvy), digitalis for auricular fibrillation and congestive heart failure, and sera used for diphtheria and scarlet fever.

Supportive treatment is treatment directed at keeping the patient in good health until the disease has disappeared and he has made a complete recovery. This consists of all mea-

sures that are conducive to helping the patient maintain his strength and energy, such as good diet, plenty of rest and sleep, sufficient intake of fluids, good hygiene, and a pleasant environment.

Before any method of treatment can be satisfactory, there must be full cooperation between the patient and the doctor. The doctor must make the patient understand why it is necessary that he follow his directions to the best of his ability so as to gain full benefit from treatment. All directions given to the patient should be simple and direct. In the hospital the nurse and the dietitian must cooperate with the doctor, for they play an important part in the treatment of the patient. In most cases the doctor takes care of all procedures which involve risk to the patient such as intravenous therapy, surgery, and x-ray studies. However, the nurse carries her share of responsibility as the doctor's assistant.

Nursing Care.—This is the full responsibility of the nurse. Not only is she in constant charge of the patient, but she carries out the treatment prescribed by the doctor. Since the nurse is with the patient most of the time, she will administer most of the treatment. Also, as frequently happens, she has to handle many psychological situations, where the outcome depends upon her judgment. A nurse must be dependable; that is, she must do what she is supposed to do, she should be accurate, and she should be discreet and tell the doctor those things that are important to the patient whom she is nursing. It is important that the nurse present a neat and clean appearance. It is comforting to the patient when he sees that the nurse is interested in her own hygiene, is careful about her work, and keeps her surroundings clean and in order. All these little things are helpful to the patient in that they create a pleasant environment that keeps him at physical relaxation as well as mental rest. Keeping the patient's room in order and the bedding smooth and neat, so that he can feel comfortable and at ease, goes a long way toward [illegible] fined to bed. Keeping th[illegible] ficult, but the nurse can [illegible] of the patient and his family. This can be done by making the patient feel he is in capable hands and that everything possible is being done to make him well. The nurse by her calm and reassuring manner may develop a close relationship with the

patient, his family, and friends that removes most of the fear of hospitals and uneasiness produced by sickness.

It is the duty of the nurse to take care of the patient's skin, hair, oral hygiene, and elimination. This is very important in patients who are bedridden for months. The daily bath is not only soothing but also produces relaxation. The alcohol back rub and massage keep the skin in a healthy condition. Particular attention should be given to the skin over the bony prominences. These areas must be kept clean and rubbed with alcohol to prevent the formation of pressure sores (bedsores). Frequent turning of chronically ill patients may help to prevent bedsores.

A clean mouth is important in keeping the patient comfortable. Cardiac patients and individuals ill with lung diseases can be very uncomfortable and distressed by the accumulation of mucus in the mouth and throat. The mouth should be cleaned before and after every meal. The nurse should keep a small tray containing a paper cup for expectoration and cotton swabs at the patient's bedside.

Elimination from the bowel should be watched so as to prevent constipation. The nurse should be alert for the onset of diarrhea and for any change in the characteristics of the feces.

Elimination from the kidneys (urine) is measured daily in some cases. It is important to know the total amount of urine excreted over a twenty-four hour period, for a decrease in urinary output may mean insufficient liquid intake or the failure of the kidney function.

A well-balanced diet is important to good health and should contain sufficient protein, carbohydrate, fat, minerals, vitamins, and liquid. In some cases the diet is restricted in certain aspects; for example, salt is removed from the diet of patients who are suffering from heart failure In other cases, such as diabetes, an exact formula for the diet is required It must contain a certain amount of protein, carbohydrate, and fat Since the activity of most patients is reduced when they are in the hospital, the meals there should be relatively small. The food should be prepared in an attractive colorful manner so as to appeal to the patient In the hospital it is the duty of the dietitian to supervise the preparation of diets. It is the responsibility of the nurse to watch the patient and to see that he eats the food prepared for him.

The nurse is required to keep clinical charts. She should record the rate of the pulse, respirations, and temperature. Any unusual changes in these should be reported. The nurse must also report any changes in the color of the skin, cough, the presence of edema, or reactions to prescribed medications.

The nursing care so far described is the usual routine care common to all patients. Frequently special procedures or treatment are prescribed, and it is the nurse's responsibility to see that they are properly administered; for example, blood pressure readings at stated intervals or the administration of oxygen in cases of cyanosis. The nurse should know how the equipment is assembled and have the necessary instruments sterilized and ready for use. When administering drugs, the nurse should know what response or untoward reactions to expect.

DRUG ADMINISTRATION

Introduction.—The most common form of treatment is by the use of drugs. Pharmacology is a branch of science that deals with study of the physiological actions, uses, dosages, and composition of the various drugs. All drugs accepted for treatment are listed in a book called the *Materia Medica*. Since the number of drugs that are beneficial in treating disease is so large, only a few of the more important ones will be discussed here.

However, before discussing the various drugs in detail, something should be said about the dosage of drugs and their methods of administration.

Dosage.—The amount of drug to be given (dose) is the amount that is necessary to alter or cure the disease or symptom from which the patient is suffering. For example, aspirin in large doses will not cure rheumatic fever, but it will give symptomatic relief of the painful swollen joints. Different drugs produce different effects when given in varying amounts. In prescribing the dose of a drug, it must be remembered that if given in too large amounts, toxic manifestations may develop. Regardless of the drug given, every patient must be watched closely for the appearance of an abnormal reaction. For example, the blocking of the kidney tubules producing anuria may occur during the administration of sulfa drugs. Such an unusual, unfavorable reaction is called an idiosyn-

crasy. In general, if an idiosyncrasy to a drug develops, the drug should be discontinued. Hives and skin rashes are frequent manifestations of idiosyncrasy. If a patient requires increasingly large amounts of a drug to obtain the desired effect, he is said to develop a tolerance for that drug. This usually occurs after long-standing treatment with the same drug. It may be due to nonabsorption, rapid elimination, or habituation. *Other factors which influence the dosage are age,* weight, sex, pregnancy, and disease For example, children require larger amounts of digitalis than adults and smaller amounts of morphine; psychosis due to atropine is common in old age.

In selecting the drug to be used, the doctor must know the disease he is treating, the effect the drug will produce, its method of administration, the dosage required, its toxic and cumulative effects, and whether the patient has previously proved sensitive to that drug.

Method of Administration.—Drugs are usually made up in the form of capsules, tablets, and fluids. When possible, they are colored so as to make them attractive and easier for the patient to take. The choice of the method by which drugs are administered and introduced into the body depends upon whether they will act best by local application, absorption through the gastrointestinal tract, or intravenous, intramuscular, or subcutaneous injection.

Oral Administration: This is the most common and convenient method. Drugs such as salicylates (aspirin), chloral hydrate, quinine, digitalis, and the sulfa preparations are more easily given by mouth. Many drugs that are given orally are also made up into preparations that may be given rectally or injected into the vein or subcutaneous tissue or muscle. Since many drugs when taken by mouth are destroyed by the gastric juice in the stomach, that is, before they enter the blood stream, it is necessary that they be administered by one of the other routes. For example, some mercurial drugs used as diuretics are destroyed when given by mouth but are effective when administered intravenously.

Rectal Administration: When patients are too ill to take medications by mouth because of vomiting or weakness, these may be given rectally following a cleansing enema. The drug

is absorbed from the rectum through the mucosal lining into the blood stream. The medicine is introduced through a rectal tube which is inserted eight inches into the rectum. If the drug to be used is irritating, it may be mixed with a few cubic centimeters of starch. After the mixture is injected, the rectal tube is slowly removed to prevent the expulsion of the substance. In most cases the rectal dose is the same as the oral.

Inhalation Method of Administration: This method is used for gaseous drugs that may be inhaled through the nose. The small capillaries in the lungs absorb the gases and give a systemic effect. The gases also act locally on the small airsacs in the lungs. For example, amyl nitrite is frequently used as an inhalant to relieve the pain produced by angina pectoris. Another example is the fine atomized spray of penicillin used as an inhalant for bronchitis and bronchiectasis.

Local Application of Drugs to the Skin, Open Wounds, and Mucous Membranes: This method is used for its immediate local effect when applied to any particular area. For example, Argyrol may be used to swab a sore throat or as eye drops. This method is also used to treat diseases of the ears, nose, and skin.

Subcutaneous or Hypodermic Administration: This method consists of injecting drugs or fluids into the subcutaneous tissues. It is used when a rapid response to the drug is desired, or when the drug will be destroyed by the gastric juice if given orally. The injections are best given where the subcutaneous tissue is loose, such as over the deltoid muscle or in the abdominal wall. Before the injection is made, the skin is prepared with iodine and alcohol The drug to be injected is drawn into a sterile syringe and the air expelled After checking to make sure that the needle is fitted tightly on the syringe, the skin is firmly pinched between two fingers and the needle is slowly inserted into and through the skin into the subcutaneous tissues.

Intramuscular Administration: This method consists of injections into muscles. The muscles most commonly used are the deltoid, gluteal, and lumbar muscles. Drugs thus injected are more rapidly absorbed into the blood stream than when given by the subcutaneous method Thus a more prompt reaction is obtained. When making an intramuscular injec-

tion, the needle attached to the syringe is plunged into the muscle. However, before injecting the medication, one should aspirate (draw back on the plunger) to be sure that the needle is not in a blood vessel. The technique used for intramuscular administration is the same as that used for subcutaneous injections.

Intravenous Administration: This method is used to introduce various fluids into a vein. It is used most commonly for the administration of such liquids as glucose and saline solution. In time of an emergency, when a drug has to act immediately, it is the method of choice. It is also used when a drug might be irritating, destroyed, or not absorbed by the other channels of administration. In most cases the best site for the injection is the antecubital vein. A tourniquet is placed around the upper third of the arm to produce venous stasis. The skin over the bulging vein is cleansed with iodine solution and alcohol, and then the needle is inserted into the vein through the skin. When the needle is thought to be in the vein, the plunger in the syringe is drawn back, and as soon as blood appears in the syringe, the tourniquet is removed and the solution is injected slowly.

Sulfonamides.—Since the discovery by Ehrlich of arsphenamine for the treatment of syphilis there has been hope of controlling infectious diseases by the uses of specific chemical agents. However, it was not until the discovery of sulfanilamide and its therapeutic effect in treating mice infected with hemolytic streptococci that chemotherapy began to make rapid advancement. In 1935 Trefonels announced that sulfanilamide was the effective component of Prontosil. Since the discovery of sulfanilamide, numerous other sulfonamides have been made, such as sulfadiazine, sulfathiazole, sulfamerazine, Sulfasuxidine, sulfaguanidine, Sulfathalidine, and sulfasoxazole (Gantrisin). The sulfonamides act by preventing the growth of bacteria (bacteriostasis).

Whenever possible, the sulfonamides should be given by mouth. They should be given parenterally if a patient is too ill to take the drug orally or if there is reason to believe that the gastrointestinal tract will not absorb the drug because of vomiting and diarrhea. For the drugs to have their maximum effect a satisfactory blood concentration must be maintained.

This is done by giving the drugs at frequent and regular intervals. The concentration of the drugs in the blood is determined at two- to three-day intervals to make sure the dosage is producing the effective blood concentration.

The use of the various sulfonamides over a period of years has shown sulfadiazine to be the drug of choice, for it is more bacteriostatic and less toxic than the others. However, sulfanilamide is preferred in patients with kidney disease since it rarely causes renal symptoms. The disadvantage of sulfanilamide is its low bacteriostatic power.

Experience has, in general, confirmed that the sulfonamides are effective against the pneumococci of lobar pneumonia and streptococci which are the organisms most frequently found in secondary pneumonias. Sulfadiazine is the drug of choice in meningococcic meningitis, chancroid, lymphogranuloma venereum, and bacillary dysentery. Sulfadiazine in combination with penicillin is the best method of treating the fulminating type of meningococcic meningitis. Since sulfadiazine is so effective in treating meningococcic meningitis, it is also used prophylactically to eliminate meningococcus carriers. This is done by giving the carrier small doses of the drug every day until cultures taken from the throat are negative for the meningococcus. Sulfadiazine in small doses is also used to reduce the number of hemolytic streptococcic carriers during epidemics, but unfortunately the organisms reappear in the throat when the drug is discontinued.

Sulfonamides should always be given in full doses Occasionally some organisms will become resistant to the sulfonamides (drug fastness). This may occur with the administration of small or large doses of the drug. The best way to prevent drug fastness is to give full doses of the drug from the onset of disease When an organism develops drug fastness, it does not lose its virulence. This may result in an outbreak of infections due to drug-fast organisms.

When sulfonamides are used, they should be given in full doses until the infection is controlled. This is easily judged by the return of *the temperature, pulse, respirations,* and blood count to normal. Only after these have returned to normal and have remained normal for three days should the drug be discontinued. If an organism proves resistant to sulfa drugs, penicillin should be used.

Sulfamerazine is similar in its effectiveness to sulfadiazine. The dosage is the same, but a high blood concentration is reached in a shorter period of time, and it is maintained for a period of six to eight hours instead of the usual four hours.



Fig 60—Morbilliform rash on chest of infant from sulfadiazine therapy (Courtesy of Dr Rosa Lee Nemir, New York University, Post-Graduate Medical School, Medichrome, Clay-Adams Co, Inc.)

Sulfasuxidine, sulfaguanidine, and Sulfathalidine are used as intestinal antiseptics. They are poorly absorbed from the gastrointestinal tract and give a very low blood concentration. They are used to reduce the number of bacteria in the intestinal tract prior to surgery on the large and small bowel. Sulfasuxidine has also been used in the treatment of cholera. None of these sulfonamides affect the amebic dysentery.

Sulfathiazole is used in urinary infections. It is effective because it is very soluble in water.

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have been discovered, but those that have proved to be the most beneficial are penicillin, streptomycin, aureomycin, Chloromycetin, and terramycin.

Penicillin: Penicillin is obtained from the mold *Penicilium notatum.* This mold occurs most commonly as the green mold on Roquefort cheese. It has a bacteriostatic power far greater than that of the sulfonamides It is not bactericidal Penicillin is not affected by the number of bacteria or weakened in its activity by the presence of pus. In most cases a high concentration in the blood stream can be obtained without the development of the toxic symptoms.

Penicillin is now available as sodium and calcium salts. Sodium penicillin is more soluble, while the calcium salt is less irritating. Because of this, the calcium penicillin is the best to use for topical application.

Penicillin is composed of four fractions: F, G, K, and X. All of these have antibacterial action except K, which is rapidly destroyed in the body. The present penicillin being used contains all these fractions Thus the greatest effect is obtained. To achieve good therapeutic results, it must be given in high doses Penicillin given by any route is rapidly absorbed and excreted in the urine. This results in early high blood concentration levels When penicillin is given intramuscularly or orally, most of it is removed from the blood in two to four hours after administration When given intravenously, the interval of time is even shorter. Penicillin diffuses well into the soft tissues of the body but poorly into the body cavities In meningitis it is best given intrathecally. In empyema it is best to inject the penicillin into the empyema cavity. Some organisms tend to become resistant to penicillin. To prevent this, adequate doses must be given in the beginning

Penicillin is effective against infections caused by staphylococci, streptococci, pneumococci, gonococci, meningococci, clostridia, bacteria causing chronic pulmonary infections, erysipelas, and anthrax. In massive doses it is effective against organisms causing subacute bacterial endocarditis such as *Streptococcus viridans.* Penicillin is effective in the treatment of syphilis and actinomycosis, and in the treatment of diphtheria in conjunction with antitoxin. Although penicillin is very effective in treating early syphilis in that blood serology becomes negative in a high percentage of cases, it is still too early

Sulfasoxazole (Gantrisin) may be used in systemic infections such as lobar pneumonia and meningitis and urinary infections due to *Bacillus proteus* and *Esch. coli.* It is one of the safest sulfonamides because it is more soluble and less toxic. Because of its high solubility it does not require alkalinization and it does not cause renal blocking. The dosage is 100 mg. per kilogram of body weight followed by 20 mg. per kilogram of body weight every four hours.

Sulfonamides are useless in virus diseases. In the treatment of these they are given prophylactically to prevent bacterial infection by secondary invaders.

Whenever sulfonamides are administered, the nurse and the doctor must watch for toxic symptoms, the most common one being skin rashes which may be of many kinds, chills, fever, nausea, vomiting, and decrease in the amount of urine (oliguria), even to the point of complete suppression (anuria). Less frequent complications are jaundice, decrease in the number of red and white blood cells, and hemorrhages into the skin. Signs of a decrease in the number of white blood cells are the development of ulcers on the mucous membranes in the mouth and sore throats. The more rare complications are signs of central nervous system intoxication, sleepiness, mental confusion, and hallucinations.

If any of the signs or symptoms of drug intoxication appear, the drug should be discontinued. Excepting the more severe reactions, the toxic symptoms will disappear upon withdrawal of the drug

When sulfonamides are given, the fluid intake and output should be measured daily A complete blood count and urinalysis should be done at least every other day To prevent the formation of sulfa crystals in the urine and their precipitation in the kidneys resulting in kidney damage, a small dose of alkali (sodium bicarbonate) is given with each dose of the sulfa drug. This prevents precipitation of the sulfa crystals and keeps the urine alkaline

Antibiotics: Penicillin, Streptomycin, Streptothricin, Tyrothricin, Aureomycin, Chloromycetin, Polymyxin, Bacitracin, Subtenolin, Aerosporin, and Terramycin.—These drugs are metabolic products of organisms which have the power of inhibiting the growth of other organisms. Many antibiotics

an ointment to be used for infected skin lesions and troches for Vincent's infection of the throat.

Reactions to penicillin are infrequent and usually transient. The reactions that may occur are chills, fever, urticaria, headache, asthma, nausea, vomiting, diarrhea, and inflammation of the veins (thrombophlebitis) at the site of prolonged intravenous injection. Only if the reaction is severe is it necessary to stop the drug. These reactions are best treated with small injections of Adrenalin, or oral administration of antihistamine drugs such as Benadryl.

Streptomycin: Streptomycin is an antibiotic obtained from the actinomycetes, an organism that is cultured from soil. This drug is a stable substance that is not readily absorbed from the gastrointestinal tract. It must be given intravenously or intramuscularly for its best effect. It shows some bacteriostatic activity against gram-positive organisms, but it is more active against gram-negative bacteria, such as *Escherichia coli*. Streptomycin has been very effective in the treatment of urinary diseases due to penicillin- and sulfonamide-resistant organisms. It is now being used in the treatment of tuberculosis, but more data are necessary for complete evaluation of the drug. Streptomycin is also being used in the treatment of tularemia, meningitis due to *H influenzae*, typhoid, paratyphoid, undulant fever, and peritonitis due to gram-negative bacilli, but its full clinical value is yet to be determined.

To maintain therapeutic blood levels, streptomycin must be injected every three to four hours. The dosage is usually 1 million units or more per twenty-four hours given in divided doses; e g., .25 Gm. every four hours Streptomycin is readily absorbed into the pleural cavity and other body cavities, but very little passes into the spinal fluid. It is excreted in the urine where it is found in high concentrations.

When first used, reactions to streptomycin were common, but now the drug has been purified and reactions occur less frequently. These are headache, nausea, fever, aching muscles, joint pains, flushing of the skin, skin rashes, and deafness.

Streptothricin: Like streptomycin, this drug is obtained from the metabolic substances produced by the *Actinomyces lavendulae* which is found in the soil It is similar to strepto-

to state its exact value as a method of treatment, especially in cases of long-standing infection.

Penicillin is ineffective against all gram-negative bacillary infections, malaria, virus diseases, tuberculosis, yeast and fungus infections, and cancer. Although frequently used, it is of questionable value in infections in which the predominating organism is gram negative.

The dosage of penicillin is determined by the type and severity of the infection. In general, 40,000 units every three hours (320,000 units per day) are required to bring most infections under control. Because of the rapid excretion of penicillin in the urine, such frequent injections are necessary to maintain a satisfactory blood level. Although penicillin may be administered by any route (intramuscular, intravenous, oral), the method of choice is intramuscular injection. For intramuscular and intravenous injection, penicillin is prepared in powder form. Penicillin tablets are available for oral administration and for aerosol therapy. In the powder form penicillin is kept in sterile glass ampules containing from 100,000 to 100,000,000 units of penicillin. For administration it is dissolved in a few cubic centimeters of sterile saline. Penicillin is also put up in oil bases such as peanut oil, beeswax and sesame oil in very high concentration—300,000 to 600,000 units per cubic centimeter. This preparation has the advantage that only one injection is required to maintain an active blood level for twenty-four hours. Also available are ampules of penicillin powder mixed with procaine which will maintain a high blood level for twenty-four hours. Tablets prepared for oral administration are coated with aluminum hydroxide or some substance resistant to the gastric juice. For oral administration five times as much penicillin must be given to obtain a satisfactory blood level For aerosol therapy, an especially prepared tablet is dissolved in sterile water and placed in a breathing apparatus through which the patient inhales the penicillin. This method is used for infections of the bronchi and lungs; e.g., bronchitis and bronchiectasis. Penicillin for topical administration is prepared by dissolving 50,000 units of penicillin in 1 or 2 cc of saline solution. It is applied locally or instilled into infected areas such as the sinus tracts of osteomyelitis. Penicillin is also prepared as

Numerous clinical trials are under investigation and clinical results are not available.

Terramycin: Terramycin is obtained from the mold *Streptomyces rimosus.* It is effective against many organisms, including many of the gram-positive and gram-negative bacteria. The dosage is 2 to 3 Gm. daily, in divided dosage every six hours. The dosage will vary, depending upon the type and severity of the infection. Terramycin seems to have a very low toxicity.

The Administration of Fluids (Parenteral).—The administration of fluids (water, electrolytes, glucose) is one of the most important therapeutic aids in surgery, the treatment of debilitating diseases, hemorrhage, severe vomiting and diarrhea, and in failure to assimilate food through the gastrointestinal tract. Each patient requires a certain amount of fluid and minerals every day to maintain a normal tissue fluid balance and regardless of his condition he must have a certain output of urine every day to remove waste products of metabolism. The urine output is used as the guide to determine the amount of oral or parenteral (subcutaneously, intravenously, or intraperitoneally) fluids needed to maintain a normal fluid balance. The total intake of fluid should equal or slightly exceed the total output

In healthy individuals thirst and hunger are the signals that make them maintain an adequate intake of fluid and nourishment. When a person is sick, these sensations are depressed and the intake of fluid and food becomes inadequate. If the illness is prolonged, the patient soon becomes depleted of water, minerals, fat, protein, carbohydrates, and vitamins.

Normally an adult needs a daily intake of 5 to 10 Gm. of salt to replace the salt lost in the urine and perspiration. This may be given as 1,000 cc of physiological saline which contains 9.0 Gm. of salt. If the patient is vomiting or has a severe diarrhea, the fluids lost are replaced by adding 2,000 cc of saline and glucose to the routine daily 1,000 cc of saline. If parenteral feedings are to continue for several days, Ringer's, Locke's, or Hartmann's solution with the addition of vitamins should be given to maintain the necessary minerals. Thus the total intake of fluid should amount to 3,000 cc or more per day. When dehydration is present and on hot days, more that 3,000 cc of fluid per day are required.

mycin in many ways except that it has less bacteriostatic power against gram-negative organisms.

Tyrothricin (Gramicidin): This antibiotic is obtained from an organism found in the soil, *Bacillus brevis.* Its effects are similar to those of penicillin on gram-positive organisms but not on gram-negative organisms. Since it causes hemolysis of the red blood cells, it is limited to topical use. It should not be given intravenously or intramuscularly.

Aureomycin: Aureomycin is derived from the mold *Streptomyces aureofaciens.* It has very low toxicity following oral administration. It is a potent drug and has been effective against virus and rickettsial infections, and gram-negative and gram-positive organisms. It has been used with success in primary atypical pneumonia, typhus, Q fever, Rocky Mountain spotted fever, lymphogranuloma venereum, and brucellosis Aureomycin should be used against infections that have become resistant to sulfonamides, penicillin, and streptomycin or in patients who are sensitive to these drugs. The dosage should be 50 to 100 mg., per kilogram of body weight per day.

Chloromycetin: Chloromycetin has been shown to be effective against scrub typhus, typhoid fever, and the other infections listed under aureomycin. The dosage is 50 mg. per kilogram of body weight by mouth followed by 0 2 to 0 3 Gm every three hours for a total dosage of 6 Gm.

Polymyxin: Polymyxin is derived from the soil organism *B. polymyxa.* It is active against gram-negative organisms such as *E coli, Br. abortus, H. pertussis,* and *B aerogenes.* Its use is limited because of its high toxicity.

Bacitracin: Bacitracin has given good results in infections following operations. It is used whenever possible as a local instillation into deep abscesses, skin ulcers, infected sebaceous cysts, etc. Many cocci are susceptible to both penicillin and bacitracin, but many that are resistant to penicillin are susceptible to bacitracin.

Subtenolin: Subtenolin is obtained from the organism *B subtilis.* It has been found to inhibit the growth of *E. typhosa, E. coli,* and a few others.

Aerosporin: Aerosporin is similar to polymyxin in the number of organisms that it will affect and its high toxicity.

that they are compatible. There are four different types of blood. These four types are determined by substances in the red blood cells called agglutinogens and are named the A and B agglutinogens. Their presence or absence determines the blood type. For example, if both are present, the blood belongs to type AB, whereas if both are absent, the blood belongs to type O. Therefore, the four blood types are AB, O, A, and B. More recently a new agglutinogen has been discovered, the Rh factor. It is best to transfuse Rh-positive patients with Rh-positive blood, and Rh-negative patients with Rh-negative blood. This factor is considered to have some connection with intravascular clumping of the newborn's red blood cells (congenital erythroblastosis, p. 247). Crossmatching is carried out as additional check to make sure that the donor's blood and the recipient's blood are compatible. A specimen of the recipient's blood serum is mixed with a sample of the donor's red blood cells. If the red blood cells do not clump, the blood is compatible. If the blood used for the transfusion is not compatible, serious fatal reactions may occur. The reaction is due to the agglutination and breakdown (hemolysis) of the donor's cells by the patient's serum. The symptoms and signs of a transfusion reaction are many. The patient may develop shortness of breath (dyspnea), bluish color of the skin (cyanosis), smothering sensations and pain in the chest, chills, fever, nausea, and vomiting. If any of these manifestations develop during the transfusion, it must be stopped at once

The indications for whole blood transfusion are many. In hemorrhage and shock a blood transfusion may well be a life-saving procedure. In acute fulminating infections and septicemia, transfusions supply needed serum protein, red blood cells, and antibodies. Whole blood transfusions replace the blood cells in such diseases as hemophilia, anemia, and purpura. In cases of severe anemia, thrombocytopenia purpura, and septic diseases it is best to give frequent, small transfusions since reactions may occur

Blood transfusions should not be given to patients suffering from congestive heart failure or pulmonary edema, because they add to the load of the circulation.

If a reaction occurs, the transfusion must be stopped immediately. The patient should at once receive 0.5 to 1 cc of Adrenalin subcutaneously. To prevent any delay, the Adrena-

In summary, the parenteral route for administration of fluids is used in the presence of hemorrhage, surgical shock, vomiting, diarrhea, peritonitis, gastrointestinal operations, and faulty digestion which results in nutritional depletion.

In general, parenteral fluids are used to maintain a normal fluid balance in the body tissues to replace the loss of body fluids and salts, to furnish food, and to keep the colloidal osmotic pressure of the blood normal.

In case of hemorrhage, surgical shock, or severe anemia, whole blood transfusions should be used to replace the formed elements of the blood (red blood cells, platelets, etc.). To maintain a normal colloidal osmotic pressure in the blood plasma, proteins should be given intravenously. These latter substances will be discussed in more detail under their individual headings.

Transfusion (Whole Blood and Plasma).—

Whole Blood: A transfusion is the removal of whole blood from the veins of an individual, followed by its injection into the veins of another individual. Transfusions may be carried out by two methods· the direct or indirect transfusion. A direct transfusion is given by withdrawing blood from the donor with a special apparatus and injecting it directly into the recipient. This method is laborious and frequently unsuccessful because the blood may clot in the tubing. In the indirect method the blood removed from the donor is added to an anticoagulant (sodium citrate) to prevent it from clotting The anticoagulant is kept in a special sealed sterile bottle and the blood from the donor is allowed to mix with it as it is withdrawn from the vein. The indirect method is the easier of the two methods and has two advantages: the blood may be obtained and carried wherever needed and all the blood need not be given at once as the sterile citrated blood may be kept in the icebox and stored for several days. Usually 500 cc of whole blood are given at each transfusion.

Before blood is withdrawn for transfusion, the donor must be checked for possible systemic disease A Wassermann or Kahn test, typing, Rh typing, and cross-matching must be done to be sure that the blood of the donor and of the recipient are compatible. A Wassermann or Kahn test is necessary to determine if the donor has syphilis. Typing is done to determine the blood type of both the donor and the recipient to make sure

growth and repair depend upon the nitrogen supplied by the protein. Some of the important antibodies and enzymes contain proteins. The hemoglobin of the blood is a protein. Proteins also contribute to the maintenance of acid-base fluid balance. The osmotic equilibrium of the blood depends on *protein acting as a colloid.*

BIOLOGICAL THERAPY

Introduction.—The treatment of disease with biological agents is based upon the introduction of a foreign material (bacteria, *virus) into the body which stimulates the tissues of the body* to produce antibodies. These antibodies can be detected in the blood. When an individual has been exposed to disease or has become infected with a disease, the body tissues respond by producing antibodies This is called an active acquired immunity. *An individual is said to have an immunity* when the body tissue fluids and blood contain antibodies which inhibit or prevent an antigen from reaching the tissue cells. Some diseases stimulate the body to produce antibodies that give a permanent immunity, while others produce antibodies that rapidly disappear from the body. Some of the diseases followed by a permanent immunity are typhoid fever, tularemia, scarlet fever, cholera, plague, chickenpox, measles, mumps, smallpox, poliomyelitis, typhus, and Rocky Mountain spotted fever. A temporary immunity (passive immunity) may be produced by administration of immune serum obtained from individuals convalescing from a specific disease

Prophylactic Biological Treatment.—This method is to produce *immunity before exposure to a disease, or at least before* it develops To do this, antigens are injected which stimulate the body to produce antibodies The antigens may be dead bacteria, bacterial products (toxins), or attenuated living organisms The dead bacteria are obtained by killing the organisms with heat or antiseptics The bacterial products or toxins are obtained from the breakdown products that appear when the bacteria die, or they are obtained from their secretions which they *produce when alive. Living organisms are "attenuated"* by passing them through animals

Vaccines: A vaccine is a substance that contains dead or attenuated living organisms. The injection of a vaccine is

lin should always be ready when transfusions are given. If rapid breakdown (hemolysis) of the red blood cells occurs, jaundice, further anemia, and hemoglobinuria will develop. If the urine is acid, the hemoglobin may precipitate and block the formation of urine by the kidneys. This results in uremia. Administration of an alkali such as sodium bicarbonate will make the urine alkaline, and this will prevent the precipitation of the hemoglobin.

Plasma: Plasma is made from whole blood. The whole blood containing the anticoagulant is placed in a large centrifuge which spins down the formed elements in the blood. The clear supernatant fluid (plasma) is removed under sterile conditions to prevent contamination. This plasma may be stored at 4° C. for many months. Many drug houses market dried plasma that is prepared by a quick-freezing process and drying under vacuum. Before use it is diluted with water Dried plasma may be stored for as long as five years. Plasma does not require cross-matching before administration.

There are many conditions in which plasma is preferred to whole blood because the qualities of the plasma rather than the red cells are needed. In shock the colloidal effect of the plasma protein maintains the blood pressure In severe burns it is necessary to supply the lost plasma protein since the body cannot meet the need or replace that lost fast enough. Plasma is also used to replace the protein lost in kidney insufficiency as a result of nephritis With the loss of proteins (hypoproteinemia), the fluids in the blood escape into the body tissues, producing edema. Following the intravenous administration of the plasma, the osmotic pressure of the plasma increases and draws the fluid that has escaped into tissues back into the circulating blood again. Transfusions of plasma are also used to restore the volume of fluids in surgical and traumatic shock and in hemorrhage

Proteins and Amino Acids.—The body maintains its nutrition by the metabolism of fats, carbohydrates, and proteins. Of these, proteins are the most important. They are large molecules composed of amino acids Twenty-three of these amino acids are known. Of these, only ten are essential in that the body cannot produce them. If they are not present in the diet, a deficiency occurs and normal protein metabolism does not take place. The functions of the proteins are many. Tissue

growth and repair depend upon the nitrogen supplied by the protein. Some of the important antibodies and enzymes contain proteins The hemoglobin of the blood is a protein. Proteins also contribute to the maintenance of acid-base fluid balance. The osmotic equilibrium of the blood depends on protein acting as a colloid.

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Vaccines: A vaccine is a substance that contains dead or attenuated living organisms The injection of a vaccine is

called vaccination. Vaccines act by producing a local reaction in the skin at the site of injection which causes the body to produce antibodies. Therefore, when an individual is exposed to the antigens of certain diseases, the antigens are destroyed by the antibodies already present and the disease is unable to gain a foothold in the body.

Vaccination with vaccines or toxins are of little value once an individual becomes infected, because they do not cause an immediate production of antibodies. It usually requires several days or weeks for antibodies produced by artificial immunization to develop. However, for rabies, artificial immunization is usually successful because of its long incubation period.

Vaccines are given subcutaneously (the vaccine is injected under the skin), and intracutaneously (the vaccine is rubbed into scarified tissue; for example, smallpox vaccination).

Virus vaccines contain living attenuated organisms which have lost their toxicity by repeated inoculation into animals, or by repeated cultures.

Smallpox vaccine is prepared from the vaccinia vesicles that appear in healthy cows which have been injected with the living, active smallpox virus In cows the virus of smallpox produces a very mild disease called cowpox. The material obtained from the vesicles is preserved in glycerine and placed in small elongated glass tubes When a human being is vaccinated with this material, a small smallpox vesicle develops at the injection site, causing the production of antibodies. These antibodies give protection against the virulent disease of smallpox

To give a smallpox vaccination the skin is cleansed with alcohol, ether, or acetone, and a drop of the vaccine is placed on the clean skin With a sterile needle the skin under the vaccine is scarified by gently pressing the point of the needle into the skin, but not hard enough to draw blood If the vaccination "takes," a small papule appears at the site of vaccination, followed on the sixth day by vesicle formation. On the ninth day the vesicle breaks down and forms a pustule If an individual is partially immune, a small papule will form that develops into a pustule on the third day. When the reaction subsides, only a small scar will remain. If an individual is immune, a small papule will form on the third day which

usually disappears without leaving a scar If an individual does not develop a reaction to the vaccine, the vaccination should be repeated. If the individual still fails to show a reaction, it is most likely due to an impotent vaccine.



Fig. 61—Primary smallpox vaccination reaction and a secondary atypical skin eruption (Courtesy of Dr Franklin H. Top, Minneapolis, Medichrome, Clay-Adams Co., Inc)

Smallpox vaccination usually protects for two to five years. After this time, revaccination is required. If an epidemic of smallpox occurs, revaccination is absolutely necessary to assure protection.

Rabies vaccine is made from dried, infected spinal cord of rabbits. A small portion of the cord is emulsified in sterile normal saline. This material is injected every day for fifteen to twenty-one days in patients who have been bitten by a rabid dog. *Vaccination against rabies is usually performed after* definite exposure to rabies and not as prophylaxis, for it is not without danger since some individuals may develop a paralysis following injection with the rabies vaccine.

Vaccines for other virus diseases that are useful and give good protection against their associated diseases are influenza, typhus, yellow fever, and Rocky Mountain spotted fever.

Bacterial vaccines consist of killed bacteria suspended in normal saline. Bacterial vaccines are prepared from special culture growths of bacteria that are kept in the laboratory. Since these cultures are called stock cultures, the vaccines prepared are called stock vaccines. A vaccine containing more than one type of bacteria, such as staphylococcus and streptococcus, is called a mixed vaccine. A vaccine containing several organisms of the same species, such as typhoid and paratyphoid A and B, is called a polyvalent vaccine. A vaccine prepared from cultures obtained from a patient's own skin lesions (abscesses) is called an autogenous vaccine.

Vaccination against typhoid-paratyphoid fever A and B is performed with the polyvalent typhoid-paratyphoid A and B vaccine (T. A. B.). The vaccine is given subcutaneously at weekly intervals for three injections. The first injection is .05 cc, while the second and third are each 1 cc. If an individual has reason to believe that he will be exposed to these diseases he is given an annual intracutaneous booster dose of 0.1 cc.

Whooping cough vaccine (pertussis vaccine) made of the bacterium *Hemophilus pertussis* has been used to protect infants and children against whooping cough. Statistics show that vaccination causes a decrease in severity of whooping cough and in many instances prevents the disease entirely. If a child has been exposed to whooping cough, revaccination should be done.

Cholera vaccine is made from the organism *Vibrio comma*. It is particularly useful in China, Korea, and Japan, where cholera is a common disease.

Plague vaccine, like cholera vaccine, is used where the disease exists. The period of immunity for these two vaccines is short (six months), and frequent revaccinations are necessary.

Other bacterial vaccines such as tuberculosis vaccine, staphylococcus vaccine, and "cold" vaccines are in use, but their value in prevention of disease is questionable.

Toxins: Toxins are poisonous substances produced by bacteria or viruses. Toxins are usually proteins produced by bacterial activity. They are unstable substances in that they are thermolabile and soluble. When toxins are introduced into animals or human beings, they are antigenic and stimulate the production of antibodies. These antibodies are also called

antitoxins. There are two types of toxin: exotoxin and endotoxin. Exotoxin is toxin excreted by the organisms. It can be separated from the organisms by filtration. Exotoxin is also called soluble toxin or true toxin. Endotoxin is retained within the organisms until they die and disintegrate.

Some individuals naturally contain antibodies (antitoxins) against certain bacterial toxins. Those individuals who lack this natural immunity are susceptible to infection when these toxins are introduced into their bodies. Good examples are diphtheria, tetanus, and scarlet fever. Immunization against these diseases is obtained by injection of the toxins to stimulate the body tissues to develop antibodies

Diphtheria immunization is performed by injecting the toxin which has been specially prepared with formalin and alum precipitate. This is called alum-precipitated toxoid. The dose consists of injections of 1 cc every month for two months. Since most children are susceptible to diphtheria infection, they should be immunized at the age of 6 months or shortly after. Before entering school, they should be given a Shick test. If this is positive, the child is reimmunized. If the child is exposed to diphtheria or if an epidemic is present, a "booster" dose of toxoid is given

Tetanus toxin used for tetanus immunization is also prepared as an alum-precipitated toxoid. The dose consists of injecting 1 cc of toxoid at monthly intervals for three months. If an individual receives a wound, he is given a "booster" dose of 1 cc of the toxoid. If the wound is severely contaminated, antitoxin serum may be given. Children should be immunized at the age of 9 months since they are frequently exposed to injury while playing in areas contaminated with dirt

Scarlet fever immunization is given to children who give a positive reaction to the Dick test It consists of five intracutaneous injections of a standard toxin or toxoid given at weekly intervals.

Biological Agents Used for Treatment of Active Disease.—These agents consist of ready-made antibodies present in the serum obtained from the blood of animals that have been injected with living or dead cultures of bacteria or their toxin. Such serum is called immune serum Injection of immune serum into the blood of the patient produces what is known as passive immunity. Immune serum inhibits the action of the bacteria

or their products immediately upon injection. Immune serum is usually given after the onset of the respective disease; however, it may be given after exposure to a contagious disease such as measles. There are two types of sera: antitoxin and antibacterial serum.

Antiserum or antitoxins are specific antibodies that inhibit the effect of toxins by combining with the toxin and neutralizing its action. These antitoxins are used against such diseases as diphtheria, tetanus, scarlet fever, botulism (food poisoning), gas gangrene, and the bites of poisonous snakes.

Diphtheria antitoxin is used in severe cases and in individuals, particularly infants, who have been exposed to the disease. The severity of the infection determines the dosage. The dosage usually varies between 10,000 to 100,000 horse serum units. Infants who have been exposed to diphtheria should receive 500 units, and older children, 1,000 to 1,500 units This gives a passive immunity that lasts about four weeks. The antitoxin may be given by the subcutaneous, intramuscular, or intravenous method. The latter method is used in the most severe infections.

Tetanus antitoxin is given to individuals who have been injured and have not been vaccinated against the disease. The dosage is 1,500 units given subcutaneously. It neutralizes the free toxin Once the disease has developed, the antitoxin will not affect the toxin which has now become attached to the nerve tissue.

Scarlet fever antitoxin is helpful in preventing the full development of the disease The dosage varies between 6,000 and 9,000 units

Botulism antitoxin consists of several types of antibodies. It is of use only if given before symptoms appear.

Gas gangrene antitoxin consists of several types of antibodies It is used in cases in which the wound is severe and penetrating and in which there is a good chance that gas gangrene may develop.

Antivenom is an antitoxin used for bites of poisonous snakes. To be effective, it must be given immediately after the bite. It is available for most of the poisonous snake bites such as rattlesnake, moccasin, and copperhead.

Antibacterial sera or antitoxins are antibodies that have been prepared against specific bacteria. They act by destroying

the germ. Such sera have been prepared for treatment against pneumococcal pneumonia, bacillary dysentery, anthrax, meningococcus meningitis, and others. However, since the advent of the sulfonamides and the antibiotics, the antibacterial sera are used only when these drugs fail to control or cure the disease.

Normal human serum obtained from individuals who have recovered from measles or whooping cough contains antibodies which will help prevent or will modify the disease through passive immunization. The antibodies are in the gamma globin fraction. It must be given within five days after exposure or it will not affect the course of the disease.

Individuals who are allergic or hypersensitive to the proteins in the horse serum may develop chills, fever, hives, itching of the skin, and joint pains This is called serum sickness Before giving serum to individuals who have a history of allergy, they should be desensitized. To determine when a patient is sensitive to a specific serum a skin test must be done. If the patient proves sensitive, he must be desensitized before the serum can be given.

Organotherapy (Hormone or Substitution Therapy).—Organotherapy is the treatment of deficiencies of certain glands with internal *secretions by giving the patient the product of the* gland obtained from animals Hormones are chemical substances that are produced in certain glands (e g, the thyroid gland) and carried to distant parts of the body where they produce their specific effect. These glands (thyroid gland, pituitary gland, ovaries, etc) play an important role in metabolism. *They are called endocrines Also included in this* kind of treatment are the liver and stomach preparations used in the treatment of blood disorders such as pernicious anemia.

The following discussion deals with the glandular preparations which are on the market and ready for use by the doctor. Since most of the hormones are not pure (they contain other active *or inactive glandular substances*), they *must* be biologically assayed. Most of the hormones have little effect when taken orally. Only a few hormones can be taken by mouth—thyroid, estrogen, and some adrenal cortex preparations.

The pituitary gland is composed of two parts: the anterior lobe and the posterior lobe Extracts of these two lobes have been shown *to have different physiological effects*

During the last three years two new hormones have become available for the treatment of rheumatoid arthritis, gout, rheumatic fever, lupus erythematosus, dermatomyositis, periarteritis nodosa, scleroderma, bronchial asthma, and pemphigus. These two new hormones are adrenocorticotrophic hormone (ACTH) and cortisone. ACTH is derived from pork pituitary glands by a precipitation method. The minimal effective dose in man consists of 5 to 20 mg. administered every six hours intramuscularly. ACTH stimulates the adrenal cortex and affects many metabolic and physiological processes in the body. Cortisone (17-hydroxy-11-dehydrocorticosterone), compound E, is prepared in part from bile acids. Dosage consists of 100 mg. every eight hours for three days, then 100 mg. every twelve hours for two doses, then 100 mg. every twenty-four hours for seven to fourteen days or less. When given in too high a dosage or for too long a time, these two hormones may cause an increased excretion of nitrogen, potassium, phosphate, and calcium, increase of the blood sugar (hyperglycemia), glycosuria (sugar in the urine), retention of sodium, chloride, and fluids, edema, muscle weakness, fatigue, high blood pressure, or increased hair growth (hirsutism).

Anterior Pituitary Hormones: The anterior lobe of the pituitary secretes two hormones with gonadotropic properties. They have a special affinity for and influence the ovary and testicle. One of the gonadotropic factors causes growth of the follicle, while the other brings about luteinization of the follicles These two hormones are of value in stimulating ovarian and testicular function They are used in failure in development of the secondary sexual characteristics in men and women, scanty or irregular menstruation, sterility, impotence, and cryptorchism They are not used in primary gonadal failure since the gonads are in a nonreactive state.

The growth-promoting principle of the anterior pituitary is considered to be of value in stimulating growth of the bones. This hormone is used to treat pituitary dwarfism It may be of some value in treating Simmonds' disease and other conditions in which there is pituitary failure.

The lactogenic principle is useful in causing increased milk production in female.

Anterior pituitary-like hormones are obtained from the placenta or the blood and urine during pregnancy. These hor-

mones are used to stimulate the male and female gonads, for cessation of menorrhagia, and to cause descent of the testes.

The posterior lobe and intermediate portion of the pituitary gland secrete two different hormones, oxytocin and vasopressin. Oxytocin causes contractions of the uterus. Vasopressin causes contractions of the smooth muscle of the blood vessels, intestines and urinary tract.

A third hormone produced by the posterior lobe has some effect upon the excretion of urine. It is called the antidiuretic hormone of the posterior pituitary gland. It has some control over the excretion of urine by the kidneys. When the posterior lobe of the pituitary gland is removed or diseased, a marked diuresis (increase in the flow of urine) occurs. This condition is called diabetes insipidus.

Ovarian Hormones: The hormones secreted by the ovaries are the estrogenic principles and progesterone. These hormones are necessary for the development of the female sex organs and menstruation. Estrogenic preparations are used in cases of ovarian deficiency, for relief of menopausal symptoms, and vaginitis. With appropriate dosage, growth of the breasts and uterus may be stimulated. Since the estrogens inhibit the function of the pituitary gland, they should be given when the ovaries are absent or when they fail to respond to stimulation from the pituitary. Most of the estrogenic hormones that are available for clinical use are obtained from pregnant mares' urine. The urine of pregnant women also contains high concentration of estrogenic principles.

Diethylstilbestrol is a synthetic crystalline hormone of high estrogenic activity. It has the same uses as the estrogenic principles.

Progesterone is a hormone secreted by the corpus luteum of the ovary. The effect of this hormone upon the female genital tract depends upon the action of the estrogenic hormone. The main functions of progesterone are to inhibit the posterior pituitary effect upon uterine muscle and to cause the endometrium to become secretory, thereby preparing the uterus for implantation of the fertilized ovum It also suppresses menstruation and causes development of the glands of the breasts. Clinically it is used in the treatment of habitual abortion, dysmenorrhea, and menorrhagia.

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Pancreatic Hormone (Insulin): Insulin is necessary for the regulation of carbohydrate metabolism. It is secreted by the pancreatic islet cells. This hormone is used in the treatment of diabetes. It is prepared in two forms; regular insulin, which reaches its maximum effect in two to four hours, and protamin-zinc insulin, which is effective for twenty-four hours.

The extract prepared from liver contains substances that are necessary for the production of red cells (erythrocyte maturation factor). Normally this E. M. F. is formed in the stomach and stored in the liver. When the stomach fails to form the E. M. F., a macrocytic anemia develops. The most important type of blood disorder that develops is pernicious anemia. Injections of liver extract produce a dramatic recovery. Once an individual develops pernicious anemia, he must be maintenanced on liver extract for the rest of his life.

GAS THERAPY—OXYGEN, CARBON DIOXIDE, AND HELIUM

Introduction.—The main function of the lungs is to maintain the exchange of oxygen and carbon dioxide between the tissues of the body and the outside atmosphere. There are two types of respirations involved during the exchange of gases: external and internal. External respiration deals with the transmission of oxygen from the inhaled air through the air sacs of the lungs into the arterial blood and the elimination of the carbon dioxide from the venous blood back through the air sacs to the outside air. Internal respiration deals with the removal of oxygen from the blood by the tissues, and in return the tissues release carbon dioxide to the blood. The lungs are involved in external respiration, while the tissues are involved in internal respiration. When there is disease of the lungs or heart, there may result impairment of respiration which results in an oxygen deficiency (asphyxia).

Oxygen *deficiency may be produced by several methods:*

1. Anoxic anoxia. *This type occurs when the amount of* oxygen in the atmosphere is lower than normal (e.g., in high altitude). Less oxygen becomes available in the lungs and in the blood to be supplied to the tissues. The same events occur in pneumonia, which reduces the alveolar area, and obstruction of the air passages (foreign bodies, asthma, tumors).

Testicular Hormones: Two forms of male hormones have been isolated for therapeutic use: androsterone, obtained from the urine, and testosterone, obtained from testicular-tissue. Testosterone available for clinical use is prepared synthetically from cholesterol. It is used to treat underdevelopment of male sex characteristics.

Adrenal Gland Hormones: Several active crystalline substances have been isolated from the adrenal cortex. One of these is desoxycorticosterone. This substance is now prepared synthetically and is thought to be more active than the commercial extracts. It has been used with some success in the treatment of Addison's disease.

Cortisone or compound E is excreted by the adrenal cortex. Its principal use is in the treatment of the collagen diseases (rheumatic fever, scleroderma, etc.). It may prove to be of great importance. Its potentialities have been discussed in Chapters 4 and 9.

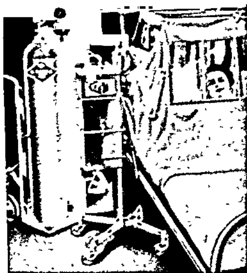
The hormone obtained from the adrenal medulla is epinephrine (adrenaline). Synthetic adrenaline has been prepared for commercial use. It has the physiological effects of natural epinephrine. It is most commonly used to reduce the swelling of the mucous membrane in allergic conditions and head colds and to raise the blood pressure of patients in shock.

Parathyroid Gland Hormones: The parathyroid secretes a hormone that affects calcium and phosphorus metabolism. Following an injection of parathyroid extract the blood calcium increases and the urinary excretion of calcium is increased. This extract is used to relieve symptoms due to hypocalcemia (tetany). Overdosage causes metastatic calcification, decalcification of the bones, and hypercalcemia.

Thyroid Gland Hormones: Thyroid gland extracts are the most commonly used endocrine products. Thyroxin is the active substance (hormone) obtained from the thyroid gland. Under normal conditions the hormone maintains a normal balance of the metabolic rate and heat production. When the thyroid gland produces thyroxin in excess, symptoms of nervousness and palpitation develop (hyperthyroidism). Thyroxin is used in the treatment of hypothyroidism, myxedema, and cretinism.

C.



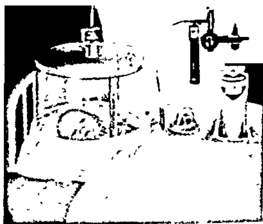


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Fig. 62 (Cont'd) —For legend, see opposite page.

A.





B

Fig. 62—Illustrations of different methods of oxygen therapy: A, by face mask; B, small respiratory chamber for infants, C, by face nasal catheter; D, regular oxygen tent with cooling system, etc., for adults. (From Meakins: Practice of Medicine)

When handling oxygen, the fire regulations of no smoking, live flames, or cautery equipment in the room or near the room must be observed.

Carbon Dioxide.—Carbon dioxide stimulates the respiratory centers; therefore, it is useful in treating atelectasis, hiccoughs, asphyxia, morphine and barbiturate poisoning, and carbon monoxide poisoning. In most cases it is used in a mixture with oxygen—5 per cent carbon dioxide and 95 per cent oxygen. Occasionally 100 per cent carbon dioxide is used to treat atelectasis and hiccoughs.

Helium.—Helium (80 per cent) with oxygen (20 per cent) is used to treat asthma and diseases that obstruct the air passages. Helium is helpful because it is so low in density that it is able to flow through the restricted airway. The oxygen concentration is increased according to the patient's need.

PSYCHOTHERAPY

Introduction.—Psychotherapy is the art of treating disease by the personal influence on a patient of mental impressions and suggestions. It is a study which involves the pathological and normal aspects of the mind. It deals with the patient's attitudes and his relations to his environment and to other persons. All doctors and nurses practice more or less psychotherapy when handling patients. A doctor who specializes in the art of psychotherapy is called a psychiatrist (specialist in treatment of mental disorders).

Supportive Psychotherapy.—Supportive psychotherapy is a method directed toward helping the patient regain his self-esteem and confidence rather than one directed against the cause of the illness. This type of psychotherapy is most commonly used in general practice. For example, a patient in a mildly depressed state is given assurance and encouragement, and interest is shown in his case by the doctor.

Quick psychotherapy deals with hypnotic suggestion provided by hypodermic injection of placebos (sterile water), placebo pills (sugar pills), electric stimulation, and hypnosis that provides a supportive-dependent relationship. For example, the relief of pain by suggestion; that is, the patient believes that the hypodermic will give him relief regardless

2. Anemic anoxia. This type is due to a decrease in number of red blood cells and low blood hemoglobin as occurs in anemia and carbon monoxide poisoning.

3. Stagnant anoxia. This type is a result of stagnation of the circulating blood. This allows most of the oxygen to be removed from the arterial blood, but since circulation is slow, an adequate amount of oxygen cannot be supplied to the tissues. This condition occurs in heart disease (cardiac failure, coronary thrombosis) and peripheral circulatory failure (shock).

Oxygen.—The main indications for oxygen therapy is oxygen want produced by any of the three types of anoxia. The most important conditions requiring oxygen therapy are lobar or bronchopneumonia, shock, acute cardiac failure, acute coronary thrombosis, severe asthma, carbon monoxide poisoning, and respiratory depression due to anesthetic gases and overdosage of morphine and barbiturates. Oxygen must be administered in known amounts. Oxygen is administered by several methods: oxygen tent, nasal catheter, and oxygen mask.

The oxygen tent consists of a transparent plastic material which encloses the body of the patient. The material is draped about the bed and tucked in under the mattress and on all sides to prevent leakage. The concentration of oxygen should be between 50 to 60 per cent at a temperature that is comfortable, about 70° F. After the tent is flooded with oxygen to raise the concentration to the desired level, a flow of 6 to 10 liters per minute is enough to maintain an adequate concentration. To operate the tent efficiently, great care must be taken in tucking in the edges so as to render it airtight.

The nasal catheter used to administer oxygen is a small 12 to 14 size Latex rubber catheter with eight holes in the terminal end. The catheter is connected to the humidifier and lubricated with petroleum jelly. It is then inserted along the floor of the nose. The catheter is held in place by taping it to the forehead. This method does not exceed a concentration of 60 per cent, so the flow of oxygen should be 6 to 10 liters per minute.

The oxygen mask fits over the nose and mouth. It has attached to its base a rubber breathing bag and an inlet for the oxygen. This method gives high oxygen concentrations. The usual dosage is 6 to 8 liters per minute.

When handling oxygen, the fire regulations of no smoking, live flames, or cautery equipment in the room or near the room must be observed.

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of what it contains. Hysteria is the most common condition that yields to this type of treatment.

Many patients have a guilt complex, or a feeling of shame or of being wicked because of some act they have done; such a guilt complex may result in an abnormal behavior pattern. As the contact and relationship between the patient and the doctor becomes one of trust, the patient will sooner or later make a confession of his shameful or guilty feeling. Through his confession the patient may receive relief from his symptoms. The doctor by his knowledge and understanding of human nature is able to explain to the patient a full meaning of various moral codes so that the patient may sense and meet his problem. This type of treatment is called mental catharsis.

Psychoanalysis.—Psychoanalysis is a special form of psychotherapy that involves the Freudian technique. It involves frequent meetings with the patient over a period of months. The doctor listens to the story of the patient's life, his ideas, emotions, dreams, and memories, and through these he is able to interpret the meaning of various symptoms, feelings, and behaviors.

Psychotherapy requires the full assistance of the nurse, physiotherapist, psychologist, social service worker, and occupational therapist for the treatment to be successful. All have some contact with the patient, and their influence can help the patient obtain an insight into his problem. The psychologist gives the patient psychological tests. The social worker investigates the background, home life, and other environmental factors that may influence the patient's mental illness and treatment. However, this treatment is subject to many pitfalls and should be undertaken only by persons especially trained therein.

PHYSIOTHERAPY

Introduction.—Physiotherapy (physical therapeutics) is the treatment of disease or injury by the use of the various physical forces of nature (water, heat, cold, sunlight, exercise, massage, electricity). The importance of physiotherapy was shown by its great use by the Armed Forces during World War II to rehabilitate soldiers. This field of treatment is used by every general practitioner and specialist. The general surgeon has

found it valuable in the aftercare of traumatic conditions of the extremities as an aid in the restoration of function. In orthopedics, superficial and deep heat and massage are helpful in many joint diseases. The contractile currents, heat, massage, and re-educational exercises are essential in the treatment of infantile paralysis and postural defects. In the numerous foot disabilities, massage and exercise are helpful in strengthening the muscles. The dermatologist frequently uses ultraviolet light to help treat skin infections.

Heat.—Local heat applied to a peripheral area of the body causes the arterioles, capillaries, and veins to dilate, resulting in an increase in blood flow to that area. Application of heat to the entire body causes a general reaction resulting in an increase in body temperature, pulse rate, respirations, profuse sweating, and output of urine. This generalized increase in body metabolism causes a loss of body fluid (water, salt) and weight. If excessive heat is allowed to continue for too long a time, dehydration, alkalosis, tetany, or circulatory collapse may develop.

Heat may be applied or transmitted to the body by conduction, convection, radiation, or conversion. Conduction is the transfer of heat from one body to another by contact. Examples of conduction are the hot-water bottles and electric heating pad. Convection is the transfer of heat to the body by circulating hot air. Examples are the hot air blower and air-conditioned fever cabinet. Radiation is the transfer of heat by passing heat rays through space. An example of this type is the infrared lamp. Conversion is the transfer of heat to the body by high frequency currents that produce heat in the body tissues. This latter method is called diathermy.

Cold.—Application of cold either locally or over the whole body causes the skin to blanch and become white. This is due to constriction of the arterioles. After the cold is removed, the vessels dilate, producing a red skin, giving the sensation of warmth. In the presence of circulatory disease, cold applications are dangerous.

Diathermy.—Medical diathermy is the use of high frequency currents to produce heat in the body tissues for therapeutic reasons. The heat produced is maintained at a therapeutic level that does not injure or destroy the tissues. The high fre-

uency current heats the body tissues through which it passes nd gives the patient the sensation of warmth.

Medical diathermy is used as an adjunct in the treatment f some traumatic conditions and inflammations of the bones, oints, bursae, muscles, ligaments, and tendons, including fracures, sprains, and dislocations, muscle strains, bursitis, tenoynovitis, myositis, neuritis, and arthritis. Diathermy should ot be used in acute inflammatory processes (acute arthritis, cute pelvic infection), acute gastric ulcer which might bleed, r nerve injuries where the sensation to heat is lost.

Massage.—Massage is a systematic passive movement of the nuscles by friction, stroking, and kneading to replace the lack of muscular exercise. It increases local circulation and maintains the nutrition of the body tissues in patients who are bedfast. Massage is used in the treatment of fracture, sprains, nerve injuries, stiff joints, dislocations, chronic arthritis, anterior poliomyelitis. Massage should not be used in acute myositis and phlebitis and other cases of local tissue injury which may become aggravated in the process.

Therapeutic Exercise.—Therapeutic or corrective exercise is scientifically controlled movements of the body. It is used for the purpose of re-educating and restoring diseased or injured muscles and nerves to function as normally as possible. There are two types of therapeutic exercise: active and passive. For either of these methods to be successful, full cooperation of the patient is necessary.

Active exercise is employed in two ways: active movement by the patient, such as breathing exercises, swimming, and setting-up exercises; and resistive movement in which the technician applies resistance to one set of muscles, thereby making another group of muscles relax.

Passive exercise is movement of muscles and joints by the technician in cases in which active movement might be harmful or in which the patient cannot participate. This type of exercise helps strengthen the muscles and improves nutrition and circulation.

Therapeutic exercise is used in spastic paralysis, acute and chronic arthritis, weakness and stiffness of the extremities, infantile paralysis, and injuries to muscles, nerves, and tendons, correction of flatfeet, and of curvature of the spine, and strengthening of abdominal muscles.

Radiant Energy.—This is treatment of disease by the use of light rays. Light rays are obtained from a natural source, the sun, or artificial sources, such as ultraviolet or infrared lamps. These rays are invisible, and because of this they are more correctly called radiant energy. Ultraviolet and infrared rays are artificially produced by passing visible light through a prism. The light that passes through the prism is broken down into its color components and is emitted as various colors of the rainbow. Below the red end of the visible rainbow is the invisible infrared ray, and above the violet end lies the ultraviolet ray. These two types of rays have different physiological effects on the body. Ultraviolet rays produce photochemical changes in the skin and stimulate metabolism, circulation, and cellular activity in other tissues. Ultraviolet rays act on the skin in such a way that the ergosterol in the skin forms vitamin D. Infrared and visible light are used for the production of heat in the superficial tissues

Present-day evidence indicates that ultraviolet rays have a prophylactic and curative effect on rickets, infantile tetany, and disease of calcium metabolism, such as osteomalacia. Ultraviolet rays have been beneficial in treating tuberculosis of the bones, joints, intestine, peritoneum, sinuses, larynx, and lymph nodes. They are used to treat acne vulgaris and lupus vulgaris. Following exposure to ultraviolet rays, the skin becomes pigmented.

Infrared radiation and visible light rays are used for the same conditions as heat. After repeated exposures, the skin becomes mottled with brown pigment.

Ultraviolet and infrared radiation should be used with care, for overdosage may cause injury to the skin and severe systemic reactions such as dermatitis, headache, nausea, and fever.

Hydrotherapy.—This is the use of water in treating disease. Hot or cold water applied to the body has the same effect on the tissues as other applications of heat and cold. Water is a very convenient method of extracting heat from and adding heat to the body. It is easy to handle and may be applied as hot or cold compresses for use on any part of the body. It may be used as local or general applications.

Local applications consist of hot and cold compresses, whirlpool bath, and sitz baths.

Hot compresses are warm, moist wrappings. The heat produced helps relieve pain in bursitis, sciatica, and lumbago. To be effective, the compresses are renewed every fifteen minutes. They are also used to prevent spread of infection by concentrating the areas of inflammation and promoting suppuration.

Cold compresses are used to lessen febrile headache and acute fever, to prevent the spread of infection and swelling in cellulitis, phlebitis, and bursitis, and to keep down the swelling in sprains and strains.

The whirlpool treatment is the immersion of the body or any part of it in water that is kept in constant motion. The effect is gentle massage and heat. It is used to treat painful stumps and scars, arthritis, and inflammation of joints and muscles. It is also used as a massage to aid in the movement of stiff joints and injured extremities.

In sitz baths the lower half of the trunk, including the hips and pelvis, are immersed in a pan of water. This is used to promote circulation in the abdomen and pelvis. This type of bath is used to treat dysmenorrhea, painful hemorrhoids, and prostatitis.

General applications consist of underwater exercise pools, ablution, full wet pack, and continuous tub baths.

The underwater exercise pool is a bath large enough to permit exercise by the patient in the water. It is used to lighten the weight of the parts of the body which are to be exercised. This permits use of the muscles of the limbs for re-education work after infantile paralysis, nerve injuries, and orthopedic operations.

Ablution is washing or cleansing of the body with water accompanied by rubbing. Cold water is used to reduce high temperatures in acute febrile conditions and warm water to produce relaxation in patients with functional disorders.

The full wet pack consists of wrapping the body in a wet sheet. This is used to control patients with severe psychotic reactions.

The continuous bath is a full bath in which the patient remains for hours or days The temperature of the water is kept constant. It is used for its sedative effects in nervous conditions and in the treatment of severe body burns.

Other methods commonly used are douches and irrigations. The douche consists of a constant stream of water against the

surface that lines a cavity. Its most important effect is cleansing. Irrigations consists of pouring or spraying a stream of water over the infected or diseased area. It is most commonly used to treat tonsillitis. This method is also used to wash out the stomach, rectum, colon, vagina, and bladder.

Fever Therapy.—The production of artificial fever by physical means for the treatment of disease has beneficial effects. Fever of this type is thought to hinder the growth of bacteria, to stimulate the production of antibodies, to increase the ability of the white blood cells to engulf bacteria (phagocytosis), and to decrease the potency of toxins. Fever therapy is a hospital procedure. A patient being treated with artificial fever requires close observation by well-trained personnel and the constant attendance of the nurses.

There are several methods for the production of artificial fever. Radiant heat is used in the form of luminous or nonluminous heat cabinets. Hot baths may be employed for short treatments with temperatures reaching 103° F. High frequency electrical currents as used in diathermy serve as a good source of heat. Inoculation of malaria produces therapeutic levels of fever. Since it produces an active disease by itself, the use of malaria has been replaced by other means. Combined fever-antibiotic therapy (penicillin) is of value in treating gonorrhea.

While fever therapy has been used in many conditions, its chief indication is to treat gonorrheal complications, syphilis, neurosyphilis, and chorea. Fever therapy has also been used to treat neuritis, chronic nonspecific arthritis, and undulant fever.

Fever therapy is not without danger, so patients must be carefully screened and closely observed during treatment. It should not be used in the presence of advanced age, rheumatic heart disease, aortic aneurysm, diabetes, cardiac or renal insufficiency, pulmonary tuberculosis, and advanced arteriosclerosis.

Low Frequency and Constant Current.—The currents used in this type of therapy are of great value in treating a limited number of conditions. The current used may be direct or alternating. Faradic current is the introduction of rapid electrical impulses for a very short time. It is used to stimulate

muscles which are poor in tone but have an intact nerve supply, such as muscle injuries, and in the re-education of muscles after fractures. The galvanic, or constant direct, current is used to produce contractions in paralyzed muscles. It is most frequently used in infantile paralysis and Bell's palsy. Shock therapy and electrically induced convulsions are used in psychiatric hospitals for the treatment of depressive states and epilepsy. The convulsions are introduced by electrical current with the hope of bringing about an electrical rearrangement of the nerve impulses with a return to their normal equilibrium.

OTHER TYPES OF THERAPY

Climate as a Therapeutic Agent (Climatotherapy).—It has been shown that climate plays an important part in the development of man and his resistance to disease. The physiology of the body in part is altered by changes in weather and climatic conditions. By climate is meant the average condition of the atmosphere at a certain place, taking into consideration temperature, rains, and wind velocity. By weather is meant the state of the atmosphere with respect to the heat, cold, calmness or storm, etc., over a short period of time.

Climate affects people in various ways. Those living in the cool temperate zone have more physical and mental energy and high resistance to infection and grow faster in stature than individuals living in the tropical zones where life is less vigorous. However, associated with this energetic type of living and sudden changes in climate is a higher incidence of disease. Toxic goiter, rheumatic fever, respiratory infection, heart failure, diabetes, and arteriosclerosis are more common in the temperate zone than in the tropical region Individuals suffering from chronic bronchitis and sinusitis and frequent upper respiratory infections may receive some relief by moving from the cold northern climate to southern California, Arizona, and New Mexico. Individuals with arteriosclerosis, rheumatic fever, diabetes, and thyrotoxicosis are benefited by tropical climate because the metabolic conditions of the body are reduced. High altitude of over 5,000 feet is dangerous for individuals with heart disease because of the reduced atmospheric oxygen. Tuberculosis is treated best in the dry warm climate of the

southwest because the heat reduces the activity and metabolic processes and lessens the chances of secondary infection.

People who have lived most of their lives in the tropics and then move out are very susceptible to infections with the sudden change in climate.

Artificial air conditioning and indoor winter heating provide a sharp contrast between indoor and outdoor air and result in abrupt atmospheric changes which make one more susceptible to infection. Air conditioning has been of some benefit to individuals suffering from allergic conditions such as asthma and allergic rhinitis.



Fig. 63.—Convalescent patient on exploratory work therapy under supervision of occupational therapist. (Courtesy of National Tuberculosis Association; Medichrome, Clay-Adams Co, Inc.)

Occupational Therapy.—Occupational therapy creates an outlet for man's desire to provide food, shelter, and clothing and to be active in some type of work. For this type of treatment to be successful the physician must have the full cooperation of the patient. The patient is given some interesting task to perform that requires mental and physical activity Activities are directed to make the patient concentrate and to forget his illness. All work performed should be under the guidance of specially trained, technical advisors. The patient must be made to feel that the work will help him.

There are numerous types of activities and work that patients may perform; for example, games help children develop their minds and bodies; wood carving, paper work, metal and leather work, and reading help patients make use of their minds and diseased extremities.

Occupational therapy is helpful in cases where the disability of the patient requires vocational rehabilitation. The patient can learn how to fill a job or to make things and thus regain his self-sufficiency.

Occupational therapy has been found most useful in restoring function to injured and arthritic joints and limbs and in bedridden and mental patients.

X-ray and Radium Therapy.—In 1895 x-rays were first discovered by the physicist Wilhelm Conrad Röntgen. Soon, additional fundamental discoveries were made in this field; Henri Becquerel, in 1896, discovered that uranium emitted x-rays; in 1896, Marie Curie and her husband Pierre discovered radium.

X-rays and radium produce the same therapeutic effect in the body. The type of radiation used for treatment depends upon the location of the diseased tissue. An attempt is made to use the method that gives the best distribution of radiation and is most effective for the lesion in question.

X-rays are produced when an electrical charge is made to pass across a vacuum (x-ray) tube. When the current stops, the emission of x-rays from the tube stops. X-rays are used for treatment of external lesions (psoriasis, skin cancer, acne, and carbuncles), deep-seated lesions of the bone (Ewing's tumor), cancer of the bowel and of other organs that has spread to other organs, sarcomas, and leukemia.

Radium produces rays that are given off spontaneously at a constant rate and cannot be accelerated or retarded. Radium is placed in special containers in the shape of small needles, seeds, or capsules. These may be implanted directly into or next to the lesion. Radium is best used to treat cancer of the mouth, tongue, cervix, and bladder.

In many cases both x-ray and radium are used together. It is more common to use x-ray or radium in combination with surgery in which all the cancer cells have not been removed.

X-rays and radium are always administered with some risk. The control of the rays and the amount of radiation must be

complete. The skin and deep tissues may be damaged in such a way that the mechanism of repair is lost. Over-radiation produces necrosis of the tissue, resulting in a chronic ulcer, and may cause the formation of cancer.

Following radiation for malignant lesions, patients should receive good supportive treatment, such as proper diet and plenty of fresh air. The red and white blood cells should be counted at frequent intervals because radiation causes hypofunction of the bone marrow.

In recent years the chemicals phorphorus and iodine have been specially treated to make them radioactive. Radioactive phorphorus is used in the treatment of disease of the bone marrow such as leukemia. Its main effect is on the bone marrow and causes a reduction in the number of red and white cells and platelets.

Radioactive iodine is administered orally and is used to treat thyrotoxicosis. The radioactive iodine is concentrated in the thyroid gland and gives off rays that affect the thyroid tissue.

Surgical Therapy.—Surgery is a branch of medicine that deals with the treatment of disease by manual or operative procedures. An operation is treatment performed with instruments by the hands of a surgeon. A surgeon is a doctor who specializes in this type of treatment.

Injury: Injury to body tissues can occur by any of five methods—trauma, chemicals, extremes of temperature, radiant energy, and pathogenic bacteria. Regardless of the agent causing the injury, there is always the danger of infection. The lesions produced by violence are called wounds.

To reduce the incidence of infection, the wound is washed with a sterile solution of water or saline to remove the dirt and dead tissue. In large, tearing wounds the dead tissue is cut away. If the wound is fresh, it is closed with sutures and bandaged. Untreated, old, infected wounds are thoroughly cleansed and left open to allow drainage Infection of a wound means previous contamination with bacteria and that time has elapsed since the injury to allow the bacteria to grow and to invade the tissue. In avulsion wounds, where a part of the body or a large area of tissue has been torn away, a skin graft is used to cover the denuded area. Skin grafts are frequently used to replace tissue lost from severe burns.

Deep wounds which might result in severance of large blood vessels may produce shock because of the loss of blood. The first step is to control the hemorrhage. This is true in the treatment of any wound, superficial or deep. In most cases bleeding can be controlled by applying pressure over the wound.

In treating fractures, certain principles must be adhered to: (1) immobilization of the fractured limb by wood or metal splints, or plaster casts, traction, or suspension; (2) reduction of the displaced bones by manual manipulation or traction. If the fractured bones have broken through the skin (compound fracture), the first treatment is to prevent infection If the compound fracture is old (six to twelve hours), surgical procedures are omitted until infection has been controlled. In fresh compound fractures the wound is cleaned and the bones set and a plaster cast applied.

Infection: In the majority of cases infections are associated with wounds, superficial abscesses (boils, deep-seated abscesses), and infected abdominal organs such as the appendix, kidneys, and gall bladder When these organs become infected, they are usually removed.

In diseases of the lungs in which pus (emphyema) or fluid (pleural effusion) develops in the pleural cavity, it is necessary to insert a special needle (trocar) into the cavity (thoracentesis) and remove the fluid Fluid in the peritoneal cavity is removed by the same method This is called paracentesis. Surgical procedures are used in the treatment of tuberculosis. The purpose is to put the diseased lung at rest to allow healing. Air may be injected into the pleural cavity (artificial pneumothorax) so as partially to collapse the lung Occasionally the pleura is held against the chest wall by adhesions, and it is necessary to cut these (pneumonolysis) to allow the lung to collapse. If tuberculosis is extensive it may be necessary to collapse the lung permanently This is done by removing several ribs (thoracoplasty) which permits part of the chest wall to collapse. Occasionally the phrenic nerve is cut or crushed so as to paralyze the diaphragm, thereby preventing its movement. This procedure is called a phrenicectomy. In cases of cancer of the lung, lung abscesses, or bronchiectasis, a whole lung may be removed (pneumonectomy).

With new and modern methods it is now possible to perform surgery on the heart and large blood vessels. Foreign bodies such as bullets and shrapnel have been successfully removed from the heart muscle, cavities of the heart, and aorta. In chronic pericarditis in which the sac (pericardium) that surrounds the heart has been infected and become scarred, it may shrink in size and cause pressure on the heart. In such cases the pericardial sac has been removed or had an opening made in it to give the heart more space. In acute pericarditis with effusion the fluid is removed with a needle and penicillin injected.

Amputation of an extremity is done if no other form of treatment is possible. This may be necessary in compound fractures, arteriosclerosis, and infection when the circulation is impaired and gangrene may set in, and when bones and flesh are so mutilated that they are impossible to repair.

Neoplasms—*Tumors:* *Tumors are of two kinds: malignant* and benign. Both benign and malignant tumors may occur in any organ in the body. Benign tumors can be removed with permanent cure. Malignant tumors (cancer) may in some cases be cured if the diagnosis is made early and the tumor and all its ramifications removed. If there is extensive local invasion of the surrounding tissue with spread to the lymph nodes or other organs of the body (metastasis), it is impossible for the surgeon to remove all the cancer cells.

Obstruction: Obstruction of the respiratory or intestinal tract is a serious surgical condition While the obstruction prevents the passage of air into the lungs and the passage of material into the gastrointestinal tract, the rapid downhill course and death of the patient are usually due to secondary changes If the trachea becomes blocked by a foreign body or swelling of the mucosal lining or tumor, the trachea must be opened below the obstruction and a tube inserted into the lumen of the trachea (tracheotomy). This enables the patient to breathe. A foreign body that becomes lodged in the bronchi of the lung may be removed by the bronchoscope. Tumors of the esophagus are treated by making an opening in the stomach through which the patient is fed. Stricture of the esophagus can be relieved by first passing small beads on a string and then gradually increasing the size of the beads

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3. What should the nurse know about any drug administered to any patient in her care?
4. What are the most commonly used biological agents and what conditions are treated by them?
5. What is meant by prophylactic biological treatment?
6. How may oxygen deficiency be produced?
7. What are the indications for oxygen, carbon dioxide, and helium therapy?
8. What are the functions and responsibility of the nurse in your hospital during gas therapy?
9. Discuss supportive psychotherapy and psychoanalysis as used today.
10. What are some of the types of physiotherapy? Discuss the conditions for which they are most commonly used.
11. In what diseases does climate play a significant part?
12. Discuss the use of x-ray and radium today.

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ntil the scarred tissue dilates Obstruction of the pylorus is elieved by attaching a segment of small bowel to the stomach 1rough which an opening is made, permitting food to by-pass 1e obstruction in the pylorus and flow from the stomach irectly into the small intestine. Small and large bowel obtruction may be relieved by removing the cause of the obstrucon or by removing part of the diseased intestine and joining 1e ends of the intestine together. In large bowel obstrucon, an opening is made from the intestine to the outside of 1e abdomen (colostomy).

Congenital Malformations: Congenital malformations are bnormal formations of the body tissues that exist at the time f birth. They may be multiple or single. Partial obstruction stenosis) of the anus or pylorus or complete obstruction atresia) requires immediate operation. Other anomalies such s clubfoot, spina bifida, harelip, and supernumerary fingers re correctible by operation later in life. Congenital malformaons of the large vessels of the heart—for instance, pulmonary enosis, which produces cyanosis in the newborn (blue baby), nd patent ductus arteriosus—can now be treated surgically ith good results.

Preoperative and Postoperative Care: The care given to the atient before and after operation is the responsibility of the irse. Good preoperative care includes the administration of uids, enemas, and sedation and mental and physical rest. 1e patient must be made to feel at ease and be given assurnce. After the operation the nurse has a larger responsibility caring for and observing the patient. She must be alert for anges in blood pressure, pulse, respirations, and temperature d for signs of shock and pneumonia If the patient complains pain, its cause must be determined before medication is ven. Special care of the stomach, bowels, and bladder is quired in most surgical cases to prevent nausea, vomiting, nstipation, dilatation of the stomach and intestinal tract, and adder distention.

STUDY QUESTIONS—UNIT V

. Classify and describe the different kinds of treatment.
. Discuss in general the functions of the nurse in all treatments

UNIT VI

HOW DISEASE IS CONTROLLED AND PREVENTED

The material here presented is planned to give a general over-all introduction to the broad field of *public health*. More specific and detailed studies of this important subject will come later in the curriculum. However, before beginning the detailed studies of the different clinical fields, the student should have a good foundation of development and activities in the public health field, and this should be integrated later in each clinical area. The background subjects of physics, chemistry, bacteriology, nutrition, and sociology are necessary for the mastery of this unit.

CHAPTER 29*

GENERAL INTRODUCTION TO PUBLIC HEALTH

Historical Background.—Public health as we understand it today was unknown to our predecessors. Primitive man lived by himself more than he did in a group, therefore, his struggle for survival *against disease and the forces of nature was more* of an individual problem. His instinct led him to seek steps that prolonged his well-being. Because disease was not understood, concepts developed that centered around religious rituals. Out of this turmoil men appeared who were able to bring the people of their time under their leadership and to

* This chapter may be studied with reference to Chapter 1

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nurses. For her service she was given a large gift of money with which she opened a school of nursing at Saint Thomas Hospital. Through her teaching, graduates of the school carried her methods of nursing throughout the world. In 1862, a social reformer, William Rathbone of Liverpool, became interested in Florence Nightingale's work, and together they established the first municipal public health service in Liverpool.

Throughout the eighteenth and nineteenth centuries, men the world over were performing scientific study in the hope of relieving the world of its sufferings. Their progress was slow and difficult due to lack of good equipment. Jenner, in the eighteenth century, proved that smallpox could be controlled by vaccination. Robert Koch isolated the tubercle bacillus in 1882. Klebs gave the first description of the *B. diphtheriae* in 1883. It was not until 1877 that Pasteur proved the germ theory. From that time on progress in the control of disease was rapid and led to the present-day public health system of accurate vital statistics and epidemiological studies. To make the system function as a nation-wide program, community health centers were formed, and public health activities were planned for personal hygiene, sanitation, communicable disease control, control of epidemics, and health supervision of children and industrial workers.

The Nurse in Public Health.—The public health nurse plays a great part in any public health program. No phase of public health escapes her influence. She is active in rural areas, schools, factories, local, city, and state health centers, and the United States Public Health Service or as a Red Cross nurse.

She has been trained to act as a teacher and advisor to the sick and families in need of help. Her knowledge of disease of the community is useful in recognizing and locating individuals in need of medical diagnosis and treatment. If disease is prevalent in a family, she secures nursing care and help for the family. She instructs the neighbors, family, or relatives how to carry out medical, sanitary, and social care so as to prevent disease. She advises these individuals on health and how to proceed with the doctor's orders.

A public health nurse is important in helping persons and families adjust themselves to their social problems following an illness. She helps teachers and social workers promote

show the advantages of preventive measures for controlling disease. Such a man was Moses, the great leader of the Jews. He made and enforced laws concerned with personal health, quarantine for individuals ill with infectious disease, isolation of lepers, and the slaughtering of animals for food.

At the same time that personal hygiene was being practiced in ancient Greece, the Romans (494 B.C.) were beginning the *practice of sanitation.*

With the approach of the Middle Ages there came a decline in the practice of hygiene and sanitation. However, the control of epidemic disease could not be pushed aside, for its control was a necessity for life. Although isolation had been practiced by the Jews before this time, its development in medieval times marks one of the great steps toward modern public health. Even though this was a method of preventive medicine, nothing was undertaken to do away with the underlying sanitary and hygienic factors which help spread disease. The Middle Ages in Europe produced two public health procedures: isolation and quarantine. Sporadic attempts at social reform were made by King John II of France, 1350, the Pope, and other leaders, but little was accomplished. The large cities were gutters of filth and remained so until the nineteenth century. This period marks the beginning of modern public health.

As early as the sixteenth century Saint Vincent de Paul, a Catholic priest in Paris, founded the order of the Sisters of Charity. They worked as public health nurses and helped, through the guidance of the priests, to eliminate some of the poverty and disease at that time.

In the year 1773, John Howard, the sheriff of Bedfordshire, made a campaign against the lack of hygiene and sanitation he found in the hospitals, asylums, and prison camps in England and throughout Europe His work produced a direct effect upon the British public, and steps were taken by the House of Commons and Parliament to better sanitary conditions of all institutions.

In the nineteenth century, Elizabeth Fry began a campaign for prison reform in Newgate Prison for women in London. She also organized women into groups who were known as visiting nurses. Such groups were, however, not recognized until Florence Nightingale returned to London from the Crimean War where she had proved the value of women as

CHAPTER 30

THE FEDERAL HEALTH PROGRAM

Health Administration in the Federal Government

The constitution of the United States does not give the Federal Government authority to make laws which govern the public health of the people. It delegates that power to the states. However, the constitution does give the Federal Government control over certain measures for the general welfare of the country. This it does through the United States Public Health Service. The individual states may receive aid through the United States Public Health Service.

In general, the Federal Government is responsible for the health of the nation and the prevention of the spread of disease between the states and the entrance of disease into the United States from abroad.

The power to regulate commerce with foreign nations and among the several states is far reaching as interpreted by the Federal Government. Control of commerce, transportation of all persons and articles, whether by land, water, or air, including all personnel (shipper, employer, employee), comes under the authority of the Federal Government. By regulating commerce, the Federal Government has the power to prohibit entrance of persons or articles into the United States when such an entry may be dangerous to the well-being of the public. The power to prohibit the transportation of an article carries with it a provision requiring inspection and proper labeling of some articles. This power is broadened by the Food and Drug Law.

The power of taxation is used to regulate public health through the Harrison Act, which controls the sale of narcotic drugs (morphine, codeine)

Although the United States Public Health Service is responsible for the health of the nation, some public health activities

health education. The development of community health programs depends upon her initiative and influence in leading the community to better health conditions. She helps spread education in preventive medicine by urging frequent medical examinations, immunization against disease, mental and personal hygiene, and good nutrition.

Although the primary aim of the public health nurse is care of the sick, she can contribute much to the advancement of modern public health.

are undertaken by other Federal Bureaus and Departments. The Bureau of The Census (Department of Commerce) compiles vital statistics. The Department of the Interior has charge of the sanitary and health services of the National Parks and the Indian medical services. The Department of Labor is concerned with the Women's Bureau and the Children's Bureau. The Children's Bureau has three main functions: to supervise the welfare, health, and employment of children. The Department of Agriculture studies the sanitation of the dairies and meat-packing houses and their products and administers the necessary laws for the protection of food and drugs.

The United States Public Health Service.—The United States Public Health Service was founded in 1798. It originated from the Marine Hospital Service which gave medical care and hospitalization to American sailors. Each sailor was required to pay a small monthly fee for his medical care. The fee was collected as tax by the Collector of Customs. Since the Collector of Customs was under the authority of the Treasury Department, the Marine Hospital Service came to be under the control of the Secretary of the Treasury. As the Marine Hospital Service grew in size, so did its authority. It had authority to issue quarantine measures at the seaports and to prevent the entrance of diseased persons from abroad. This was later increased to include assistance from the state and municipal health agencies. Following further expansion of the public health functions of the Marine Hospital Service, its name was in 1812 changed to the United States Public Health Service. The Surgeon General was made the responsible head. In 1939 Congress transferred the United States Public Health Service to the Federal Security Agency. Thus, after one hundred forty-one years the United States Public Health Service was removed from the jurisdiction of the Department of the Treasury. This change made possible closer cooperation with the state and local health authorities. In 1944 the United States Public Health Service was reorganized. It was divided into four large divisions, each under the guidance of an Assistant Surgeon General. At the present these consist of the Office of the Surgeon General, the National Institute of Health, the Bureau of Medical Services, and the Bureau of State Services. These are further divided into other

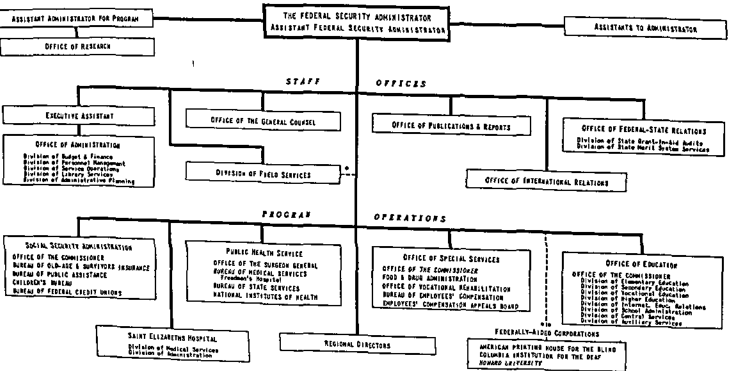


Fig. 64 —Chart showing organization of the Federal Security Agency

sections and units necessary for the performance of the public health functions. The functions of the United States Public Health Service are many. Some of these are:

1. *Ship quarantine*, which allows for inspection on all ships and airplanes from foreign ports and examination of immigrants and passengers and the crew.
2. The *publishing* of public health information.
3. *Correlation* of the Federal Health Service with state and local health units.
4. *Interstate quarantine* to prevent the spread of communicable disease from state to state.
5. *Medical research activities* on diseases to study their cause, prevention, and cure.
6. *Standardization* of biological products such as vaccines, sera, antitoxins, toxoids, and arsenical products; issuance of a federal license to manufacturers of biological products.
7. *Study* of drug addiction and mental disease, their causes, prevalence, treatment, means of prevention.
8. *Investigation* of the cause, treatment, and prevention of venereal diseases.
9. *Medical and psychiatric service* to Federal prisoners
10. *Operation* of twenty-six marine hospitals.
11. The *training* of personnel to assist state, cities, and local communities in the operation of their health departments.

Vital Statistics.—Vital statistics is the collection, tabulation, and interpretation of facts dealing with human births, deaths, morbidity, marriages, and divorces These facts and figures give to the Public Health Service important information regarding community health throughout the nation Each state has an official State Registrar of Vital Statistics who is responsible to the State Health Office for compiling all the data on births, deaths, etc. All the information obtained by the registrar is forwarded to Washington.

The registration of births is the obligation of the individual responsible for the delivery of the child The birth must be reported within ten days. Each stillbirth is reported as a death and a birth. The birth rate is the number of live births per 1,000 population for any certain year.

$$\frac{\text{Number of live births}}{\text{Total population}} \times 1{,}000 = \text{Birth rate}$$

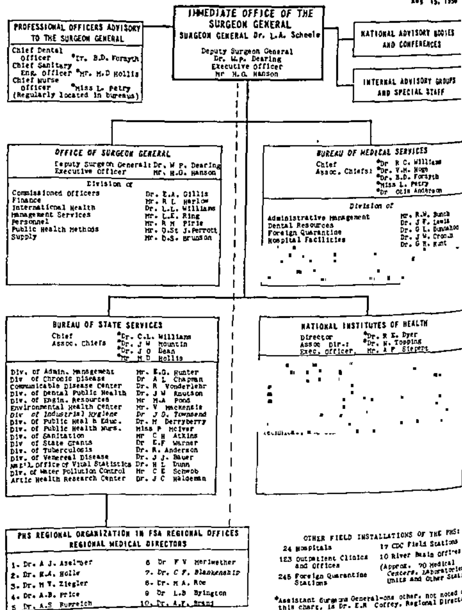


Fig 65.—Chart showing organization of the United States Public Health Service.

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The registration of births is the obligation of the individual responsible for the delivery of the child. The birth must be reported within ten days. Each stillbirth is reported as a death and a birth. The birth rate is the number of live births per 1,000 population for any certain year

$$\frac{\text{Number of live births}}{\text{Total population}} \times 1{,}000 = \text{Birth rate}$$

Deaths are reported to the local registrar by the individual who has charge of the burial of the body. Deaths should be reported within forty-eight hours. The medical data on the death certificate are filled out by the physician who took care of the patient during his last illness. In case of accidental or sudden death or death from unknown causes, during which time the individual was unattended by a physician, some states provide a coroner or an official medical examiner.

The crude or general death rate is the number of annual deaths per 1,000 population. For example, if the number of deaths for a city of 100,000 were 1,000, then the crude death rate would be 10 per 1,000.

$$\frac{1{,}000}{100{,}000} \times 1{,}000 = 10$$

The infant mortality rate is the number of deaths under 1 one year of age per 1,000 live babies for one year.

$$\frac{\text{Number of infant babies}}{\text{Total number of live births}} \times 1{,}000 = \text{Infant mortality rate}$$

The maternal mortality rate is the number of deaths from puerperal causes per 1,000 live births.

The morbidity rate or illness rate is the number of cases of a certain disease per 100,000 population, in relation to the population of an area. All states require the reporting of certain dangerous or contagious diseases to the health department.

Although the registration of marriage and divorce is not a part of the public health department, the state registrar, for convenience, is responsible for the data collected.

State Health Administration and Functions

Under our form of government each state is a sovereign power and responsible for the health of its citizens. The different states are governed through acts of their legislature. The authority of the legislature is limited only by the state constitution. The legislators enforce health regulation by making public health laws. In general, these laws cover two groups: laws on public health organization and laws controlling public health administration. As can be seen, the state health program has a direct connection with the state legislature It is also important to know the difference between a state law and a state health regulation. A state law is an act of the legislature that falls within the limiting power of the state

constitution. A state health regulation comes from the board of health or health commissioner and is based upon a law passed by the state legislature.

The public health program of the states must be considered from a general viewpoint. There are forty-eight states, and each state is a sovereign power so each has developed a public health program to meet its own individual needs. Because of this, no two states have identical health organizations, and it is impossible to lay down the principles of a state health program that would be suited to all the states.

Organization of the State Health Department.—Regardless of the type of organization used in a public health program, the work to be done is the same. In most states the state health officer is appointed by the governor. Most often the governor also appoints the members of the board of health. The appointments of personnel in the various state health departments are made by the state health office or, in some states, under civil service. The number of health departments or administrative divisions are many and usually include communicable disease control (tuberculosis, venereal disease), mental diseases, heart disease, cancer, maternal and child hygiene, sanitation, laboratories, local health work, public health nurseries, health education, vital statistics, food sanitation, and industrial hygiene. Some states also include bureaus that deal especially with malaria control, nutrition, and dental hygiene.

In general, the relationship of the state to municipal and county health departments follows the plan that exists between the Federal Government and the state. The state acts only as the advisor. It directs most of its activities to the rural area where health facilities are lacking However, the state stands ready to give service and aid to the cities and counties when needed. However, there is a difference in that the Federal Government may only assist or advise the states on its public health matters, while the state government is supreme and the local government has only the authority granted to it by the state legislature.

The state health department is in constant communication with the United States Public Health Service and other state health organizations. Through their relationship and cooperation, many health programs are developed and put into function so as to improve health conditions.

Since the number of administrative divisions of the sta is large, the present discussion will be limited to the Divisi of Communicable Diseases and its control over certain disease

Control of Communicable Diseases:

A communicable disease is a disease which may be tran mitted from one individual to another by direct or indire means. While many communicable diseases to which man susceptible are human-borne, some are transmitted by anima and insects. Organisms causing communicable diseases ma be classified as follows:

1. Bacteria, as in typhoid fever, lobar pneumonia, an diphtheria.
2. Filterable viruses, as in measles.
3. Protozoa, as in malaria and amebic dysentery.
4. Spirochetes, as in syphilis and yaws.
5. Rickettsia, as in typhus fever.
6. Molds, fungi, as in ringworm.
7. Yeasts, related to molds, as in thrush.
8. Parasites such as nematodes (ascaris and hookworm) cestodes (tapeworm), and trematodes (flukes).

Communicable diseases are most commonly classified a being sporadic, endemic or epidemic, or pandemic. Sporadi means single cases occurring here and there. Endemic pertain to a disease which is constantly present in a group of peopl in a given community, such as measles. Epidemic means tha a disease attacks a large group of people in any region a the same time and is widely spread. Pandemic means diseas spread over the entire nation or even the world. A goo example is the pandemic of influenza that occurred in 191 and spread over most of the world.

Tuberculosis: Tuberculosis is one of the oldest diseases known to man. It is an important disease not only because of the number of deaths it causes, but also because of its high morbidity rate The discovery of the tubercle bacillus by Robert Koch in 1882 opened the door to scientific management of the disease. Roentgen's discovery of the x-ray in 1895 made it possible to diagnose the disease early. These discoveries permitted well-planned epidemiological studies and revealed

the true incidence of the disease, its prevalence among the different races, and the age groups affected. The greatest incidence is between the ages 20 and 45 years.

As the knowledge of tuberculosis increased, new methods of treatment developed. Patients were placed on well-planned regimens of good food and rest, personal hygiene was improved, collapse therapy of the lungs was introduced, and tuberculosis sanatoria were built. Educational programs and campaigns made the people realize that the disease could be prevented, treated, and cured. Through these aids the social stigma that tuberculosis once held has been lessened.

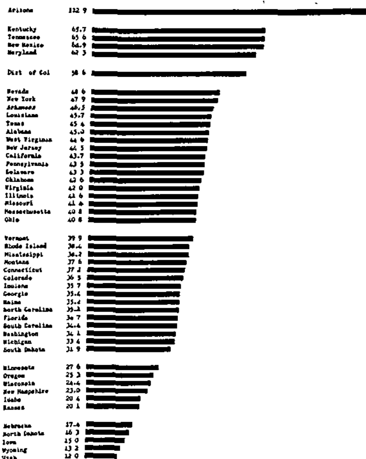
The above-mentioned factors have brought about a constant decline in the death rate from tuberculosis. In 1900 tuberculosis led all other diseases in the cause of death, with a rate of 194.4 per 100,000 population. In 1940 the death rate was 45.9, in 1941 it was 44.4, while in 1944 the death rate was 41.3 per 100,000 population.

Age, sex, race, and economic status play an important role in the incidence of tuberculosis. Statistics show that the lowest death rate from tuberculosis is in the group from 5 to 14 years of age, while the highest death rate falls in the group between 25 and 34 years of age. A careful analysis also shows that with age there is a progressive increase in the number of deaths. Sex plays a minor part, but the mortality rate among women tends to be somewhat higher than that among men. The mortality among Negroes is about three times that for the white population. The incidence of deaths from tuberculosis is high among people with a low income and in individuals working in certain industries such as miners and stone cutters.

Because of the necessity for widespread public health work to fight tuberculosis, a voluntary agency called the National Tuberculosis Association was formed. This group has been valuable in the help it has given to the state, county, and local health departments in carrying out the necessary programs for prevention, control, and treatment of tuberculosis. Under the authority of the United States Public Health Service is the Tuberculosis Control Division whose main work is to eradicate tuberculosis. An antituberculosis program must be far reaching and must include facilities for (1) finding new

Tuberculosis Death Rates Per 100,000 Population Among Residents of Each State — 1944

Death Rate for the United States — 41.3



[60] THE NTA BULLETIN FOR APRIL, 1946

Fig. 66.—Graph showing tuberculosis death rates per 100,000 population in every state—1944 (Courtesy of National Tuberculosis Association; Medichrome, Clay-Adams Co , Inc)

cases, (2) adequate hospital treatment and isolation, (3) aftercare and rehabilitation, and (4) care for the welfare of the patient's family.

In a case-finding program a certain group in a community is selected for x-ray examination of the chest. This examination may reveal not only active cases, but also suspected cases and individuals with other chest conditions that need medical treatment. This type of extensive chest x-ray study along with periodic or yearly physical examination is gradually becoming routine in state schools, universities, colleges, medical schools, nursing schools, and many large industries.

The public health nurse has played an important part in the tuberculosis control program. Through her home visits and work in the clinics she is in a position to assist in finding new cases of tuberculosis. She helps carry out the doctor's orders for individuals who are ill with tuberculosis but are on bed rest at home. She assists the patient and his family to adjust to social and financial problems. To achieve such responsibility, the nurse must have a good knowledge of tuberculosis, its prevention, treatment, pyschological aspects, and predisposing factors, and home nursing.

The modern method of treatment of tuberculosis consists of absolute bed rest, adequate diet, and maintenance of good body health to allow the body to fight the tubercle bacillus. Streptomycin and other drugs are now being used for treatment, and they have shortened the time of disability somewhat, but it is still too early to state their real value. All tuberculous patients should be isolated and kept away from members of the family and friends. For the best treatment the patient must be placed in a hospital or sanatorium. Not only is the patient treated here, but he also learns how to care for himself and to protect himself Most states have hospitals that maintain a section for tuberculous patients, or sanatoria limited to the treatment of tuberculosis.

Besides the treatment listed above, doctors use another method that aims at placing the diseased lung at rest. It is called pneumothorax This is done by injecting air into the pleural cavity that lies between the chest wall and lung. The injected air is under higher pressure and causes the lung to collapse. In most cases the diseased lung is kept collapsed for several years while the healthy lung carries the burden

of the work. To keep the diseased lung collapsed, air is injected into the pleural cavity every few weeks.

It is not always possible for patients to be treated in a hospital or sanatorium. In these cases home treatment is necessary. It is almost impossible to treat patients satisfactorily in the home. The required rest, removal of anxiety and worry, close medical supervision, and regularity of hours are lacking. In home treatment the public health nurse is of untold value. She visits the home at regular intervals, advises and cares for the patient, helps the family prepare the special diets, and sees to it that the family and patient have periodic physical examinations.

For adequate treatment and isolation of tuberculous patients, a city of 100,000 population should have sixty to eighty beds available, based on the recommendation that two hospital beds be made available for each death that occurs annually. A good example of how a tuberculosis plan functions is seen in Middlesex County, Massachusetts, which has a population of 900,000. The administration is so arranged that each county tuberculosis hospital sends members of its own staff to certain districts to help maintain the local diagnostic clinics. The nurses are supplied by the local health department. These clinics enable the doctors to follow patients who have been discharged from the hospital. It is essential that all the local clinics have adequate x-ray, laboratory, and treatment facilities.

Tuberculosis is a disease that requires long treatment. This is costly and causes the patient many economic and social problems. Through rehabilitation programs the patient is helped to regain his self-confidence and gradually assume his responsibilities without overdoing or overworking. Placing too heavy work on a patient too soon may cause a relapse.

Venereal Diseases: Syphilis, gonorrhea, chancroid, granuloma inquinale, and lymphogranuloma venereum are the communicable diseases designated as venereal diseases. All five are spread by sexual contact. The two most common venereal diseases are syphilis and gonorrhea. These also pose the most difficult public health problem. Until the last few years most people were ashamed to discuss openly the dangers of venereal disease. This, in turn, led to the lack of support of governmental steps and programs for its control.

The organisms that cause syphilis, gonorrhea, etc., are specific and entirely different from one another. However, all five diseases have several factors in common such as (1) method of spread, (2) social problems, and (3) the social stigma placed on the diseases by the public. This last factor has made it difficult to compute accurate mortality and morbidity figures. Too often the disease is not reported in order to save an individual or his family from shame. Frequently false names are placed on the reports.

The prevalence of venereal disease infections was vague and unknown until World War I, when a study was made and attention was directed toward the high incidence. It was found that over 2 million days of service were lost in 1917 and 1918. Through the leadership of Surgeon General Parran, public opinion was aroused, and he succeeded in obtaining money from the Government to help the states and cities bring venereal disease under control. In 1918 a Division of Venereal Diseases was formed in the United States Public Health Service. In 1938 the Venereal Disease Control Act was passed, giving the United States Public Health Service power to grant Federal aid to states with statewide venereal disease control campaigns This allowed for cooperation between the Federal Government, state, and local health departments and expansion of their clinics and laboratories. This is shown by the action some of the state legislatures have taken in passing laws requiring examination for syphilis of individuals applying for marriage licenses and of all pregnant women At least thirty-two states now require such examinations.

Through the close cooperation of public health authorities and private physicians, the public has gradually come to know the truth about venereal disease and has demanded medical treatment. To supervise and maintain control of venereal disease, states have formed separate health divisions of venereal diseases or a division of communicable diseases. State and local hospitals and private hospitals with outpatient departments and dispensaries maintain clinics for the diagnosis, treatment, and prevention of venereal disease. While most of these clinics are free, some charge a small fee to cover expenses The state also maintains laboratories for the use

of the work. ... into the pleu ... weeks.

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state. Many states require vaccination in the first year of life and for school attendance. The recommended method is smallpox vaccination for infants before the age of 1 year and repeated vaccination every five years. It must be remembered that no one fails to give some sort of reaction to smallpox vaccine. If no reaction occurs, two things may have happened: (1) the vaccine may have lost its potency or (2) the vaccine may not have been properly introduced.

Diphtheria: Epidemics of diphtheria are as old as historical records. An American physician, Samuel Bard, was one of the first to recognize diphtheria as a communicable disease. In 1883, Klebs, a German, described the diphtheria bacillus. This was confirmed by another German worker, Loeffler. Diphtheria antitoxin was developed by Emil von Behring in 1890. He was responsible, with Theobald Smith, Roux, and William H. Park, for developing a modified toxin that produced an active immunity. In 1914 Shick proposed the intradermal test for determining susceptibility to diphtheria. This is now called the Shick test.

Programs to prevent the spread of diphtheria have been developed through the cooperation of state, city, and county health departments and private physicians In well-baby clinics pediatricians use diphtheria toxin-antitoxin and toxoid to immunize the infants and small children Statistics show that the highest incidence of diphtheria occurs before the age of 12 years and that most deaths occur under 6 years of age. So the immunization program should be centered around preschool children and those in the first and second grades.

In most communities toxoid is given to all children up to school age for most of them are Shick positive. In older children and adults toxoid is withheld until the Shick test is done. If positive, toxoid is given If the test is negative, the individual is considered to possess sufficient antitoxin and immunity.

Typhoid Fever: Two important factors have brought about the rapid decrease in the number of cases of typhoid fever. These are (1) sanitation and (2) vaccination. Even with modern sanitary methods and precautions it is difficult to prevent infected material from reaching the mouths of people. Typhoid fever germs reach the mouth through contamination of food by the fingers and flies. Such foods as milk, water,

of the physician or patients without cost. Also through the state laboratory drugs necessary for treatment are furnished free.

To direct and supervise this work, some states have appointed one or more physicians. The public health nurses are assigned to work in the clinics and make house calls.

The United States Public Health Service reports that more than 1,000,000 cases of syphilis are treated each year. Some 500,000 of these patients are new cases, while 600,000 are advanced cases. This means that approximately one person out of ten acquires syphilis. These figures also mean that approximately three per cent of the population have or have had syphilis in one of its various forms. Statistics show that syphilis is the cause of 10 per cent of all mental illness, 15 per cent of blindness, and many of the deaths due to heart disease. An expectant mother with syphilis who is not treated before the fifth month can transmit the disease to the fetus. A child born with syphilis is said to have congenital syphilis. Approximately 2 per cent of children are born with congenital syphilis.

Studies of gonorrhea reveal that 1,000,000 persons develop gonorrhea each year.

Smallpox (Variola): Before Edward Jenner discovered smallpox vaccine and demonstrated its use, smallpox was one of the major causes of death and disfigurement. By vaccination this disease has almost been eradicated. Smallpox is still found throughout the United States, but the number of cases reported each year has been progressively smaller. This is because more people have been vaccinated. Vaccination produces an immunity that is effective for many years. Individuals who have had smallpox have a long-lasting immunity. In 1902 the mortality rate was 6.6 per 100,000 population, while in 1910 it was less than 0.1. In 1911, 1,132 active cases were reported as compared to 316 cases reported in 1915.

Epidemics of smallpox are rarely seen nowadays, but small outbreaks do occur in communities where vaccinations are not common. Areas where vaccination is widely practiced are immune to epidemics. Smallpox outbreaks are most common in the late winter months.

In states with rigid vaccination laws, the incidence of smallpox is consistently low. Vaccination laws vary from state to

become involved. The care of individuals with mental disorders and the promotion of a mental hygiene program became a matter of public health interest in 1909 when the National Committee for Mental Hygiene was formed. It is a private organization whose leadership and work are maintained by psychiatrists.

The prevalence of mental disease is much higher than is generally recognized. It is estimated that 3 persons per 1,000 population have a mental disorder. The incidence is lower in Negroes than in whites and some six times higher in families of very low economic status than in homes of the higher classes. Further estimations are that over 500,000 people are in hospitals for mental disease besides those in private institutions and individuals who are under supervision outside the hospital. Annually, over $165,000,000 are spent in the United States for care of the mentally ill.

Almost every state now has a separate division in its public health program for care of the mentally ill. Because of the great demands made on society, the state has assumed the responsibility for the mental care and hospitalization of individuals suffering from mental disorders The state hospitals maintain mental hygiene clinics at the hospital and in rural districts under the service of the hospital and in cooperation with the county and local public health centers and hospitals

The Federal Government acts through the United States Public Health Service only as an advisor to the states in its methods of controlling and treating mental diseases. The mental hygiene division of the United States Public Health Service maintains Federal hospitals for members of the Merchant Marine, Federal prisoners who become mentally ill, and drug addicts.

In large cities the public school educational program includes a mental hygiene clinic which deals with mentally defectives and with children with behavior problems and maladjustments. To aid children who are backward and unable to maintain their scholastic standing, special classes are held under the supervision of special teachers trained in child psychology. The juvenile courts of most cities now have a psychiatrist who in an advisory capacity studies each juvenile delinquent.

Admission to a private mental hospital is a private action, but admission to a state mental hospital requires a legal court

and vegetables frequently become contaminated by the improper disposal of human excreta (feces and urine). The health department usually employs a sanitary engineer who is responsible for and has control over sanitation measures of sewage disposal, water supply, pasteurization of milk and milk products, disinfection of produce and supervision of shellfish and fisheries, sanitation of swimming pools and bathing beaches, public eating houses, food handlers and carriers, and prevention of breeding of flies.

Typhoid "carriers" are individuals who have recovered from an attack of typhoid fever but continue to carry the typhoid organisms in their urinary or gastrointestinal tract (gall bladder) or other organs in the body. Although the organisms no longer cause symptoms in a carrier, they can be spread through him to other individuals who are susceptible to the typhoid bacillus. Women are more commonly carriers than are men. Treatment for typhoid carriers is frequently unsatisfactory. Some cases have been cured by removal of the gall bladder and appendix which are frequently sites of chronic infection.

Present-day vaccination for typhoid fever is done with a polyvalent type of vaccine that gives protection against typhoid fever and paratyphoid A and B. Typhoid vaccination is now a routine procedure in the United States Military Forces. Most pediatricians vaccinate children against typhoid fever between the ages of 1 and 2 years. Persons living under poor sanitary conditions or individuals who have been exposed to infection should have vaccine at yearly intervals

One need only to look at the decrease in the death rate due to typhoid fever to see how effective sanitation measures and vaccination have been. The typhoid fever death rate for troops in the Civil War was 1,961 per 100,000 men as compared to 5 per 100,000 men in World War I

Mental Diseases: Mental hygiene is a subject which deals with prevention of mental disease and the development of healthy mental and emotional habits It is concerned with drug addicts, alcoholics, delinquents, illegitimate children, and prostitutes. These unfortunates are found in all stations of society, and because of the necessity for their care, the states, schools, churches, industries, and community neighborhoods

tricians to start a nation-wide campaign for the treatment and prevention of rheumatic fever. As a result of its work, Congress appropriated money to assist the state public health agencies to care for these diseased children. The state Rheumatic Fever Public Health Agency used this money to set up health centers where facilities are available for treatment, nursing care, and social work. The states usually employ a full-time pediatrician for the program.

The biggest and most difficult problem comes after the patient has recovered from the acute stage of rheumatic fever or chorea. The aftercare, supervision, and observation must extend over a long period of time Without the assistance of public health nurses and medical social workers, efficient care for these patients would be impossible The public health nurse makes home visits and instructs the patient's family in the necessary nursing care according to the doctor's orders. The medical social worker investigates the home and family needs and obtains help from the local community agency for their welfare.

Many national organizations such as the American Council of Rheumatic Fever, American Hospital Association, American Nurses' Association, American Association of Medical Social Workers, and the American Heart Association are giving valuable assistance to the problem of heart disease.

The American Heart Association is a national organization organized by doctors who are interested in the study, prevention, and treatment of heart disease. It has many affiliated committees that carry out programs of research in heart disease (arteriosclerosis, hypertension, rheumatic fever, etc.), programs for professional workers who want further training in heart disease, heart clinics, and public education and fund raising for financial aid. Many of the doctors in the states and local communities interested in the study of heart disease have organized and formed state, city, and county heart association groups that meet frequently to study the problem of heart disease.

The National Heart Act created the National Heart Institute. It is under the control of the Federal Security Agency. It is active in programs of research and training and in the promotion of public health measures for control of heart disease Its main functions are (1) giving funds to states for furthering

action in which the patient is declared insane. The patient has interviews with several psychiatrists or physicians who are qualified to determine whether the individual's mental condition justifies his removal from society to a hospital.

State laws forbid the marriage of an individual of "unsound" mind. However, the laws are lax in that there is no definite method of determining whether an individual is mentally ill. Therefore in effect many marriages occur among such individuals. Some states through acts of legislature have gone farther to prevent the influence of heredity by permitting sterilization of mentally defectives and mentally ill patients.

Heart Disease: Heart disease is the leading cause of death in the United States. Since the year 1900 the percentages of deaths due to heart disease have steadily increased. In 1940 a census showed a mortality of approximately 292 per 100,000 population for a certain area. In 1943 the total number of deaths in the United States due to heart disease was over 400,000 This increase is in part due to newer methods of diagnosis which were not available in the past when many cases of heart disease were not recognized. Also, with modern methods of treatment and control of childhood diseases, people live longer and this makes heart disease more prevalent in the aged. Increases in the death rate are shown by the registration figures of 1940 In 1940, 92 per cent of the deaths due to heart disease occurred among the 27 per cent of the population who are past the age 45 years. Deaths due to heart disease are twice as common in men as in women. Heart disease prevails among men between the ages of 45 and 65 years. On the whole, the death rate in the Caucasian race is higher than that in the Negro.

Early diagnosis is the keystone of any health program for the control of heart disease. The responsibility for this lies primarily with the private physician who is the one most likely to see the early cases, he is also responsible for their further care in which skillful management may greatly contribute to prolonging the life of cardiac patients.

Rheumatic heart disease is the most common cause of death from heart disease in school children Over 35 per cent of deaths in this age group are due to rheumatic fever This high mortality rate caused the American Academy of Pedia-

With the continuous increase in the number of deaths from cancer, a more intensive study of the disease became imperative. In 1914 the American Society for the Control of Cancer was founded for the purpose of publicizing "cancer" and its hazards in order to make the public conscious of the disease and the value of early diagnosis and treatment if symptoms appear. Further impetus was given to the problem of cancer when Congress passed the National Cancer Institute Act in 1937. This Institute was placed under the authority of the United States Public Health Service with the Surgeon General as its chairman. The main function of this Institute was cancer research. To allow for expansion of its work the National Advisory Cancer Council was formed. The main function of the Council is to conduct studies of cancer control programs and medical education programs throughout the United States.

Almost all states now have a program in effect, including free clinics with adequate diagnostic and therapeutic facilities. Such clinics are centrally located The service given by the doctors is free, or a small fee is charged according to an individual's ability to pay. Most medical schools have large cancer clinics in their own hospitals Other clinics are located in city or private hospitals. States that lack a state-wide program must depend entirely upon the services offered by the private and city hospitals.

Educational programs have been valuable in giving information to the public concerning the latest developments in the field of research. Some states hold educational campaigns ("Cancer Week"). Through the distribution of magazine articles, radio broadcasts, pamphlets, and educational campaigns, lay people have become more helpful in cancer control work.

Several things should be generally known about the early symptoms of cancer, for instance, that cancer is painless in the early stages; that open sores that fail to heal after treatment for two or three weeks may be early cancer; that every lump in the breast should be examined by a physician; that a wart, mole, or wen that shows changes, such as bleeding or growth, may be undergoing abnormal cell regeneration.

the progress of control of heart disease, (2) sponsoring demonstration programs for prevention of heart disease, and (3) working with local and private agencies in studying public health measures that will bring about the control of heart disease.

The National Health Institute conducts a program of public health control through its Heart Disease Control Branch. This branch has field demonstration units which help the local communities, in cooperation with the Public Health Service, the state and local health departments, the state and local medical societies, set up programs for the prevention and control of heart disease.

These programs usually consist of methods to determine the type of heart disease most common in a local community, to interest the local physicians in the program, to study the needs of the patients with heart disease, and to determine how the public health department and local agencies can best help the heart patient.

Cancer: The word "cancer" as used by the United States Registration Area includes all types of malignant tumors. Cancer is the second most common cause of death in the United States Cancer is more common in women than in men. More than 160,000 people die from some form of cancer annually. The true trend of the death rate from cancer can be seen by comparing the figures of the mortality rate for tuberculosis and cancer from the year 1900. In 1900, the number of deaths due to tuberculosis was three times that of cancer. Now the death rate due to cancer is almost three times that of tuberculosis. Several factors have brought this about. cancer may not make itself apparent until it has spread to involve organs where surgical removal is impossible; many cancers are not amenable to surgery, x-ray, radium, or any form of treatment. The percentage of deaths shows a marked increase from the age of 20 years, reaching its highest level between the ages of 15 and 65.

Some parts of the body are more frequently sites of cancer than are others. Of the 160,000 deaths due to cancer in 1910, the disease originated in the gastrointestinal tract in 50 per cent, in the uterus in 10.6 per cent, in the breast in 9.8 per cent, and in the throat and mouth in 3.2 per cent.

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CHAPTER 31

MEDICAL CARE IN URBAN AND RURAL AREAS

The public health problems of small cities, towns, and country areas differ from those of large cities. A city of 25,000 population should have a health department of its own. A city of 25,000 or less will be considered with the rural areas in respect to their public health administration.

Municipal or Local Health Administration.—A city is a group of people occupying a relatively small area subject to state regulation. Each city is granted a state charter which contains certain rights and privileges. Because of their size, some cities, for example, New York City, are granted almost complete self-government The state health department acts as an advisor and supervisor to the city health department. In case of an emergency, the state may take full charge.

The city health department is the essential unit of the public health service. It is one of the principal departments of city government. Some states use a system by which the local health departments are under the direct control of the state health department. Others use a method by which the state may advise or investigate the local health department but lacks any direct control except in emergencies This last form seems to be the most satisfactory form of local health administration. The administrative program is centered around a board of health This board of health and its appointed officials are responsible for the health of the community

The board of health is made up of a small group of responsible civic-minded citizens interested in public health affairs and the welfare of the community. The number of members on the board of health varies between three and five. They are appointed by the mayor The main functions of the board are: to act as advisor to the health officer, to make rules and

regulations and determine the general policies of the health department, and to approve appointments of personnel by the health officer.

The health officer is the director of the local health department. He is appointed by the mayor, county commissioner, or board of health. His main functions are: (1) hiring of personnel, (2) organization of administration of the health department, (3) budget planning, (4) health education, (5) communicable disease control and epidemiology, (6) sanitation, and (7) hygiene.

The administration of a public health department varies from city to city and is determined by the population of the area and size of the health agency. One factor common to all is the responsibility which each health department has for the welfare and general health of the community. In general, the functions of a local health department may be listed as follows:

1. *Vital statistics*—Compilation, recording, and analysis of data and publication of data on births, deaths, and communicable diseases
2. *Communicable disease control*—venereal disease, tuberculosis, malaria, etc.
3. *Hygiene*—prenatal and maternal hygiene, infant and preschool hygiene, and school hygiene
4. *Sanitation*—Food and milk control, including food processing, public eating places, and industrial sanitation
5. *Public health laboratory*
6. *Health education* of the general public

The cost of city health work varies between one and two dollars per capita per annum. These figures are recognized as minimum for an ideal health program. With aid given by voluntary agencies without cost and money paid by patients' families, the actual cost to the cities usually runs below one dollar With the gradual increase in the cost of medical care, group insurance plans such as the Blue Cross and Blue Shield have been formed to lighten the impact of illness on the family budget. At present Congress and the American Medical Association are studying National Health Insurance for the entire population of the United States, but such a plan is not finding much support at this time.

Many cities have developed centers through which they can bring health services to more of their residents. The health centers are located in strategic areas not too close to downtown districts of the city. The health center has as its administrator a district health officer. The health center should include the necessary facilities for clinic services such as a well-baby clinic, tuberculosis clinic, dental clinic, immunization clinic, laboratory, quarters for public health nurses, sanitary inspectors, welfare and social organizations, voluntary organizations, and agencies engaged in allied activities.

Rural Health Administration.—The local health departments of rural districts are also under the control of the state. However, the state usually grants more leniency to the health departments of the towns and counties. The basis for this is logical since the rural areas require less stringent supervision than the cities where so many persons live in close proximity.

Some states have put into effect a health program of dividing the rural areas into districts, each with a district health officer. This method has been valuable in controlling communicable diseases, and in epidemiological investigation. However, this method does not provide a well-rounded health service. To help this problem, voluntary organizations such as the Red Cross and Anti-Tuberculosis Association have set up public health nursing centers.

The most effective method of administration of public health service to the rural areas is through the organization of a county health department supported by county funds. This advancement was made possible through the work of Dr. L. L. Lumsden, of the United States Public Health Service Later the state health department offered its help by assuming responsibilities for the health work in the counties

The plan of organization for a county health department consists of a county board of health, health officers, sanitary inspector, clerk, and nurses whose functions are the same as those of the municipal health centers.

Since many counties contain large cities within their boundaries, it is best to incorporate both health departments into one for efficiency. However, most cities maintain their own health department separate from that of the county.

Lighting.—Good lighting is essential. Primitive man could work only from sunrise to sunset since the sun was his only source of light. The camp fire was used for cooking, heating, and protection (to keep away the wild animals). In time, candles, oil lamps, kerosene lamps, and illuminating gas came into use in various parts of the world. These methods were used until 1879 when Thomas Edison invented the incandescent bulb. This was followed by other new inventions such as indirect lighting and fluorescent lights.

Direct sunlight is not only a source of light, but it also acts as a disinfectant. Sunlight should be allowed to enter homes and working places as much as possible. It should not be allowed to shine directly into the face for it stimulates sensory nerve endings in the eye, producing pain, blinking, and excessive lacrimation (watering of the eyes). This also happens if strong artificial light is permitted to shine directly into the eyes

The eyes of man can readily adjust to light and darkness. This is accomplished by the muscle contractions of the iris, Like any muscle, the muscle of the iris becomes fatigued if it is continuously stimulated to contract and relax. This is the reason that flickering lights result in eyestrain, headaches, nervousness, and fatigue Excessive glare causes prolonged contraction of the pupils with the end result of muscle fatigue

Any form of lighting to be ideal must be sufficient and without glare or contrast in intensity and have constant illumination. Good lighting is based on the illumination on the working area and not by the brightness of the lamps Since dark objects absorb more light than white objects, they require more illumination

Artificial illumination is usually considered under two headings: (1) position of the source of light and (2) its nature (direct or indirect) Artificial light is used as a general and localized source. For general lighting strong lights are placed a long distance from each other and used to illuminate large areas For localized lighting as reading lamps, a few lights are used to illuminate a small area

Direct lighting comes from a direct source without obstruction to the flow of light as in unfrosted electric light bulbs In semidirect lighting the light from the bulb is partially shaded and most of the light is reflected to the ceiling, then to the

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The factors that produce discomfort are elevated temperature, lack of moisture, and stagnation of air.

The body produces heat through the oxidation of food. As in the case of any machine, some of this heat must be lost to operate efficiently. Body heat is constantly being lost. Heat is lost through the expired air, the discharge of excreta, and ingestion of cool liquids and food. Most of the body heat is lost through the skin. Heat loss from the skin occurs by several processes. When exposed to normal room temperature, the body loses heat by radiation; for example, heat radiates from the body to the cool objects in the room, such as chairs and walls. Heat loss by convection is accomplished by replacing the warm air surrounding the skin with cool air. Some heat is lost by conduction through direct contact (touching) with cold objects. If one becomes too warm and perspires, this moisture on the body is lost by evaporation. High surrounding temperature reduces the process of radiation so a greater loss of heat occurs by evaporation. If the room temperature falls below 60 degrees, a sensation of chilliness is felt. At a low room temperature the skin and the small arteries contract, and this produces "goose flesh" and shivering. These body reactions take place to reduce the loss of body heat. The sensation of cold is relieved by muscular exercise, which increases oxidation, and by wearing heavier clothes.

The water content of the air has a definite effect upon the heat loss of the body and the comfort one feels. If the air contains a large amount of moisture, it is unable to absorb perspiration on the body, and if the movement of air is slow, the interchange of the high moisture air around the body is also slowed. This prevents loss of heat by evaporation and radiation. As a result one feels uncomfortable and warm. The water content of the air is expressed as relative humidity. This means the actual percentage of moisture in the air as compared to the maximum amount of moisture the air could hold at the same temperature. Temperature affects the amount of moisture air can hold. At high temperatures, the air can carry larger amounts of water. Discomfort from high humidity is relieved by wearing clothes that absorb moisture and by using electric fans, which cause the air to circulate. Many hospitals have installed humidity controls in the operating

room. Indirect lighting is reflected light entirely. The source of the light is hidden. This is the most desirable type of light since is produces less shadow and softer light. It is most commonly used in hotels, theaters, public buildings, and homes for general lighting. It is not satisfactory for close work.

For all-around use, the fluorescent light is rapidly replacing light bulbs. It gives a more uniformly bright light, and its efficiency is higher.

For measuring the intensity of illumination, a foot candle-meter is used. Illumination is measured in "foot candles"; this means the amount of illumination at a point one foot from a standard-sized candle.

Ventilation and Heating.—The concept that good ventilation depends on fresh air overlooks three important factors; the temperature of the air, its moisture content, and the movement of the air. These factors have a physical effect upon the body. The sense organ of the body that is most susceptible to changes in ventilation is the skin. It is important in raising and lowering body temperature. A good example is the pleasant stimulating sensation one feels when stepping from a hot, crowded room onto a breezy outside porch. The reverse of this gives one the sensation of feeling hot and stuffy and the air has a disagreeable odor.

Since ventilation is concerned with the air we breathe, it is natural for most people to think that in a crowded room with poor ventilation a feeling of "stuffiness" is due to the lack of oxygen. Through respirations an exchange of oxygen and carbon dioxide takes place in the lungs. The air we breathe is a mixture of oxygen, nitrogen, carbon dioxide, and other gases The per cent concentration of the three main gases are. oxygen, 21.0; nitrogen, 79.0; and carbon dioxide, 0.04. The high concentration of nitrogen has little effect on the body since it remains fairly constant

The idea of "crowd poison" being a result of an accumulation of carbon dioxide in the air breathed and rebreathed has long been disproved It has been shown that carbon dioxide concentration in the air breathed and rebreathed remains low Also the oxygen content of the air remains about the same. However, oxygen depletion will occur if there is a flame-heating apparatus such as a fireplace in the crowded room.

Modern ventilation systems such as air-conditioning units employ these same principles. However, they are so arranged mechanically that they automatically regulate the relative humidity, temperature, and air movement and remove dirt, bacteria, and viruses from the air. Through this thermostatic control unit the inside air is kept constant and the windows need not be opened.

Indoor heating is accomplished by several methods: central heating by a hot air furnace (coal, wood, oil, gas) usually located in the basement, which has large connecting pipes that lead off to the rooms, or steam furnaces which have a circuit of hot water or steam flowing through the pipes and radiators. This latter method is most commonly used for large office buildings. Solar heating, which is the most modern method, uses the sun through reflection to heat the indoor air Another new system is being employed which makes use of the principles of radiation and convection and keeps a more uniform temperature in all parts of the room In combination with any one of these types of heating, an air-conditioning unit may be installed with an electrostatic device for removing dirt and bacteria. Some hospitals, homes, and factories have installed these newer methods of heating and have found them very satisfactory.

HEALTH ORGANIZATIONS USED IN TIME OF DISASTER AND EMERGENCIES

Disaster often strikes without warning. The only way to handle such emergencies is to be prepared. Most localities are not set up to meet such situations. Every few days we read in the newspaper or hear over the radio about floods, fires, hurricanes, earthquakes, etc. The chaos that follows is greatly increased by lack of preparedness and the lack of community organizations other than the fire, public health, and police departments, which are not equipped to meet disasters on a grand scale.

How to be *prepared for emergencies* was well *demonstrated* during World War II by the different branches of the armed forces both at home and overseas In the United States an emergency program was organized under the National Defense Council. Under this council each state formed a defense program. The governor of each state was given the authority to

room, delivery room, and nurseries. Large industries such as candy manufacturing companies and textile plants use humidity controlling devices to keep the air dry.

Well-ventilated rooms lack disagreeable odors. Odors from the glands of the feet, axillae, clothes, and decayed teeth are always more noticeable in humid air. As the moisture of the air increases, disagreeable odors become more objectionable.

In general, the requirements for good ventilation are: (1) a supply of clean fresh air (1,000 cubic feet per hour per person), (2) maintenance of proper temperature (between 65 and 68 degrees F.), (3) relative humidity between 50 and 75, (4) air movement strong enough to keep the air moving, and (5) air free from bacteria, irritating gases, dusts, and unpleasant odors. To maintain these fundamentals of good ventilation in large buildings and spaces lacking windows, it is necessary to provide machinery that will bring the air in from the outside and at the same time remove the air already in the room. It is also necessary to filter, heat, dry, or add moisture to the incoming air.

There are two methods of ventilation; natural and artificial.

In natural ventilation inside air is replaced by outside air through openings in the building. All buildings allow air leakage. A large portion of the air enters through open windows, chimneys, and cracks and around the windows and under doors Most solid structures or walls are porous and this allows for the passage of air. When the outside air is cooler than the inside air, the cool air will flow into the building at a speed dependent upon the difference of the two temperatures. If the inflowing air moves at too rapid a rate, it can be felt as a cool breeze or draft. The drafts are best controlled by ventilators and screens.

Most large buildings such as business offices, factories, and churches use an artificial or mechanical ventilation system to bring about an exchange of air. In general, there are three types: (1) the vacuum or exhaust system which uses a motor-driven fan that removes air from the room by suction and at the same time draws fresh air into the building, (2) a system which uses motor-driven fans to propel fresh air into a room, and (3) the combined method which uses a fan to push air into a room and a fan to exhaust air.

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ings that were destroyed. If financial aid is needed, it can be obtained in most instances from local societies, the Red Cross, and the Federal Government.

The Red Cross.—The National Red Cross was granted a charter by Congress in 1905. This gives it authority to give aid any time a disaster occurs. It is a voluntary organization, active in public health work. It acts through a central office and its local chapters and associations. The operating funds come from public donations. This has the advantage that its budget is not limited by state or community legislation.

When disaster strikes, the local Red Cross immediately comes into action. It sends its own personnel and equipment to the disaster area, but it remains under the authority of the local officials. The local Red Cross agency supplies food, clothing, shelter, and medical and nursing care for needy persons. The National Red Cross enters the scene of disaster whenever the magnitude of the disaster requires it and at the request of the local officials or governor of the state.

The American Legion.—The American Legion has worked out a program with the Red Cross in which it can give disaster assistance. Because of its large membership, the American Legion increases the source of manpower which can aid in rescue work and in obtaining and handling supplies and serve as medical and transportation aides.

take the necessary steps to enforce a defense program which would protect the people within the boundaries of his state. In turn he delegated power to the mayors of the cities and had smaller communities call together the civic leaders and formulate groups who organized the people to act as emergency crews in case of disaster. The work was done on a voluntary basis without pay. The directors of the fire, public health, and police departments and the American Legion and Red Cross organizations gave courses in first aid, home hygiene, nursing, sanitation, and warden services. The people of the community thus trained were placed under the guidance of its leader and assigned certain duties. In time of an emergency these trained persons were called. Such a program gives a working nucleus through which a community can handle a disaster without too much confusion, unnecessary suffering, and great loss of life. With the present threat of atomic warfare civil defense is again being organized with special reference to the major emergencies which will arise if large centers of population are attacked from the air without warning.

A good example of disaster is the earthquake with which the West Coast is constantly threatened. When one occurs, the damage can be unlimited It calls for immediate action of all public health and civic organizations. These groups of civilians who have been trained as emergency crews are called and instructed as to what to do.

The public health officer takes charge of all matters pertaining to health and sanitation. His duties include protection of the water supplies, sewage disposal, refugee centers, immunization centers, care of the injured, setting up of first-aid stations, general sanitation, and supervision and care of food and milk.

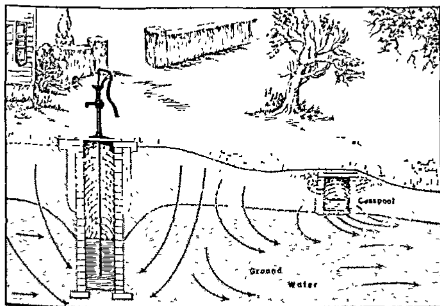
In case of fire, the fire department crew with its civic members and the police department assist in controlling the crowds, fighting the fire, rescuing trapped persons, and assisting with the transportation of the injured.

After the emergency has been controlled, the rehabilitation program begins. All organizations combine their efforts to reconstruct the homes, public water supplies, streets, and build-

For convenience, water is classified as good, contaminated, or polluted. Good water is water that has been tested and found safe for drinking. Contaminated water is water containing waste products from industrial plants and plant growth. Polluted water is water that contains organisms found in excreta and may be infectious.

In general, there are five main sources of water. lakes, oceans, rivers, springs, and wells.

The water obtained from the oceans, lakes, and rivers is called surface water. That from the springs and wells is termed ground water.



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Surface water is rain that has fallen directly into the rivers, lakes, or oceans or on the ground. The water that strikes the ground may be absorbed by the earth and soak through the dirt to underground rivers or lakes, or it may run over the surface of the earth to enter a lake or river As the water flows over the earth's surface, it picks up many foreign par-

CHAPTER 32

SANITATION

WATER SUPPLY AND SANITATION

Water is necessary to sustain life of man. A study of the transportation maps will reveal that most large cities or towns are located near a large body of water such as a lake, ocean, or river. Man built his earliest communities near water for two reasons: water supply and ease of transportation. As the cities grew in size and population problems of sanitation arose, new and large supplies of water had to be developed and installed Inadequate disposal of waste products, especially human excreta, became a menace to health. The rivers and lakes were used for sewage disposal and were thus continuously polluted with human and animal wastes. To prevent this, sewage disposal plants were developed. To supply the cities with sufficient clean water, skilled sanitary engineers were employed to build local reservoirs, water-pumping plants, and aqueduct systems with central treatment stations One individual uses approximately 100 gallons of water daily To allow for the extra amount of water used in caring for wastes, farming, and industries, each individual is usually allowed 200 gallons of water per day If necessary, as in time of emergencies due to floods, an individual can get along with only 65 gallons of water per day providing it is prorated for drinking, cooking, washing, bathing, and wastage.

Water has been the carrier of bacteria that have caused many of our greatest epidemics. Polluted water has been the cause of cholera, typhoid fever, and amebic dysentery. These diseases are so commonly associated with polluted water that the public has come to appreciate the value of clean, safe water.

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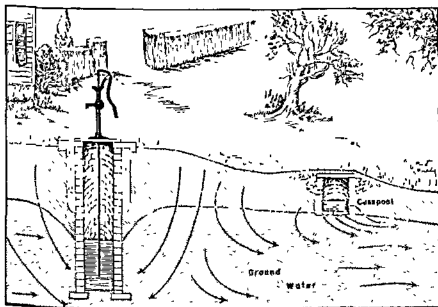


Fig 67—Underground water moves slowly toward streams or lakes Cesspools should be so located that wells will not be contaminated by their drainage. The danger of pollution is less in sand and gravel soil, but these may finally become saturated and permit infection (From Turner· Personal and Community Health, The C V Mosby Co)

Surface water is rain that has fallen directly into the rivers, lakes, or oceans or on the ground. The water that strikes the ground may be absorbed by the earth and soak through the dirt to underground rivers or lakes, or it may run over the surface of the earth to enter a lake or river. As the water flows over the earth's surface, it picks up many foreign par-

ticles such as small plants and animals, bacteria, minerals, dirt, and plant and wood fibers. If the water should flow over ground contaminated or polluted with pathogenic germs, they, too, will become a part of the water. So, water that appears clean to the human eye may be contaminated with disease germs and other substances. Water removed from the lakes and rivers and stored in reservoirs is called a surface water supply. Artificial lakes are made by placing a dam across a river bed, causing the water to back up and act as a large storage basin.

Ground water is water obtained from wells and springs. It comes from underground lakes and rivers and from water that has soaked through the earth. This water is usually safe for drinking as it is free from most disease germs and foreign material because of the filtering process of the sand and gravel in the various levels of the earth. However, some areas of the sand and gravel may have a break in their formation which allows for improper filtering and removal of the bacteria and foreign material. This is particularly true of shallow surface wells. Deep wells are safer but they too may become polluted. Wells should be placed a good distance from all buildings, barns, and privies. If the privy is located on a slope, the well must be placed above it or on a greater elevation; otherwise drainage from the privy will pollute the well water. To be sure that the water is safe, samples should be sent to a state or local public health laboratory for examination.

Rain and snow are our ultimate sources of water. They are present in the atmosphere in the form of water vapor. Under certain climatic conditions this water vapor will precipitate and form either water or snow.

Rain water has been a direct source of home water for centuries. It is collected in a rain barrel or tank placed at the side of the house under a water trough or out in the open. Rain water is low in minerals. This makes it soft and useful for washing.

Communities located on low ground usually lack enough pressure to pump the water through the pipes to provide all homes and industrial plants with water. To build up pressure, machine pumps are used to pump water into tanks placed on high towers. This allows gravity to act as the pressure agent.

colonies is recorded as the number per cubic centimeter. In general, most bacteria produce a colony that can be differentiated by its growth characteristics (color, shape, size). Broths to which various sugars have been added are inoculated with the different bacteria and they can be classified according to the sugars they ferment. To determine if water is polluted, special search is made for certain bacteria such as *Escherichia coli, Bacillus typhosus, Vibrio comma,* and *Shigella dysenteriae.* Of these, the bacillus *Esch. coli* (common inhabitant of the large bowel) is the easiest one to culture and grow. Its presence indicates pollution.

The chemical examination includes tests for nitrogen compounds, chlorine, magnesium, and carbonates.

Nitrogen may be present as nitrites, free ammonium, albuminoid ammonia, and nitrates. These compounds are present in two types of chemical substances: organic and inorganic.

Nitrogen passes through a cycle or course of events during which it is acted upon by bacteria, soil plants, and sunlight and transformed into such substances as complex nitrogen proteins and the nitrogen compounds listed above. The steps in the cycle may be listed as follows:

1. Plants and sunlight take up inorganic nitrogen from the soil and form plant proteins.

2. Animals eat the plants and produce complex nitrogen proteins.

3. Animals die and through the action of bacteria and oxidation the complex nitrogen proteins are broken down into the simple nitrites, nitrates, free ammonia, etc.

The presence of very small amounts of nitrogenous substances in water indicates pollution For example, the test for nitrites is one of the most sensitive chemical reactions' It reveals 0.01 parts of nitrites per million. The presence of nitrites usually indicates recent bacterial activity because in the breakdown process nitrites are oxidized to nitrates Nitrates are more stable than the nitrites When found in high concentration, they indicate pollution. It is not uncommon for ground water to contain more nitrates than surface water because the nitrates of the ground water are not available for plant utilization.

Water is tested for free ammonia by heating; it then gives off the ammonia which can be recognized by its odor. Its presence also indicates pollution.

Albuminoid ammonia is ammonia produced from the protein products of animal and vegetable matter when distilled with alkaline potassium permanganate. If most of the ammonia comes from the plant protein, the water is colored and the nitrogen compounds are more stable.

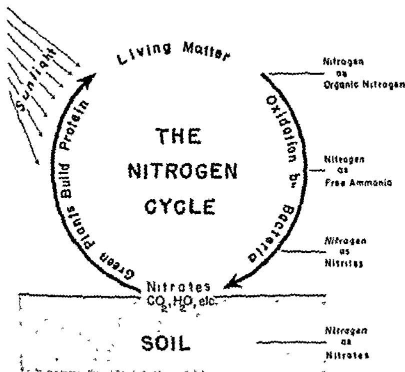


Fig. 68.—The nitrogen cycle (From Turner *Personal and Community Health.*)

Water that contains a high concentration of calcium and magnesium carbonate is called "hard" water. When soap is added to "hard" water, these alkaline compounds displace the sodium in soap and form a precipitate which appears as a scum on the surface of the water. By adding such substances as lime and sodium carbonate, the calcium and magnesium salts are precipitated and the water becomes "soft." The reason rain water is "soft" is because it contains no chemicals.

Normally, small amounts of chlorine are found in water. It is present in the form of the salt, sodium chloride (NaCl). The chlorine in water comes from two sources: urine and salt that comes from salt air that floats in from off the ocean. Therefore, water coming from the sea coast usually contains more chlorine than that obtained from inland sources. Inland water containing more than the normal amount of chlorine has been polluted.

Purification of Water.—Most of the water that is available for use is unsafe for drinking. As a safeguard various methods of purifying water have been developed. The most common methods used are storage, filtration, and chlorination.

The old idea that the swift running of rivers and streams purifies the water is false. Any upstream pollution may make water unsafe for cooking and drinking. However, nature does attempt to purify water. Swift-running water causes a reduction in the number of bacteria; waterfalls and "rapids" spray the water, producing a fine mist which mixes with the air, allowing absorption of oxygen and the loss of carbon dioxide (aeration); sunrays help kill the bacteria on the surface of the water and help plant photosynthesis.

Storage: This is the most simple and inexpensive method of purifying water. It is a self-purification method. As water stands in an enclosed container such as a tank, lake, or pond, all foreign material (bacteria, dirt, plants) settles to the bottom. In localities where lakes and ponds are absent, large reservoirs are usually constructed. The water is stored for one month at summer temperature. This is considered long enough to purify the water. It is best to have two large water tanks or reservoirs so that one can be in use while the other is allowed to stand for the required thirty days. If water is stored in the open air, various types of marine or vegetable life may appear in the water, and these will color the water and give it a strange taste. Closed reservoirs eliminate this.

Filtration: This is a method by which water is allowed to pass through a sand filter. There are two types: the slow sand filter and the rapid sand filter or "mechanical filter."

The slow sand filter is a large square basin the bottom of which is covered with cement. Leading off from the bottom are drains that remove the filtered water. On top of the cement

floor are layers of tile, crushed stone, gravel, coarse sand, and fine sand. The water on top filters through the various levels of substrate by force of gravity. The sand and gravel particles act in two ways: They block the flow of bacteria, and they attract the foreign matter through electrostatic force. Through constant use, the various levels of sand, etc., become clogged and they must be replaced from time to time. The slow sand filter removes 98 per cent of all bacteria and foreign particles. Calculations show that one acre surface of this type of filter will clear 3 to 5 million gallons of water per day.

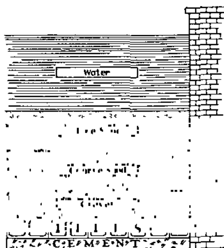


Fig. 69—Section through a slow sand filter. The water soaks through the fine sand, the coarse sand, and the gravel, entering the open tiles which carry it to a collecting basin. (From Turner Personal and Community Health.)

The rapid sand filter differs from the above method in that a substance such as lime or alum (aluminum sulfate) is added to the water. These substances are called coagulants. When these chemicals are added, they react with the alkaline salts and form aluminum hydroxide, which appears as a sediment. This precipitate makes contact with the bacteria and dirt and together they settle to the bottom. After this has been done, the water is piped off and filtered through a filter similar to the slow sand filter. However, it differs slightly from the slow sand filter in that it is smaller and contains a coarser sand.

Chlorination: The adding of chlorine to purify water is the most common method used. Chlorine is added in the form of gas. *Its* concentration is one part per million. When chlorine is added to the water, hypochlorous acid is produced. It is this acid which kills the bacteria. However, the concentration of chlorine used varies from time to time, depending upon the amount of organic material and type and number of bacteria present.

In time of an emergency (war, flood) or when camping out or traveling or marching as the soldiers had to do during World War II, available water is frequently impure. Purification of small amounts of water by boiling for one minute is the simplest method; however, too frequently it is impossible to build a fire. Besides, boiled water tastes flat and lacks flavor. This is a result of the loss of the gases due to its agitation while boiling. If water is shaken after the water has been boiled and allowed to cool, air is resorbed and part of the taste returns For convenience and for saving time, several methods have been devised for purifying small amounts of water with chemicals. This is particularly important during war. The chemicals most commonly used are chlorinated lime (bleaching powder) or tablets containing chlorine (for example, halazone tablets).

When using bleaching powder, one teaspoonful is added to one pint of water The mixture is stirred and allowed to settle From this mixture 9 drops are removed and added to one quart of water.

Halazone tablets were used almost exclusively by the soldiers during World War II. The process of purification consisted of adding two halazone tablets to a canteen of water. The water was shaken thoroughly until the tablets dissolved and then allowed to stand for thirty minutes to one hour before using.

Other chemicals that have been used for purifying water are tincture of iodine, copper sulfate, and ozone. Some hotels, bath houses, and swimming pools have installed ultraviolet ray machines to which the water is exposed for thirty seconds. This kills pathogenic bacteria.

Miscellaneous Uses of Water.—Water placed at free use of the public is always a potential source of an epidemic. Public

places such as drinking fountains, swimming pools, and public beaches are under the control of the local health department. It is the responsibility of the health department to make frequent checks on the water to make sure it is free of pathogenic bacteria.

Prior to the introduction of the modern drinking fountain, a common drinking cup was placed at the water station, and it was freely used by everybody. This permitted uncontrolled contamination of the cup and transmission of bacteria from one person to another. The original drinking fountains did lower the danger of contamination but they too were unsatisfactory. They were so constructed that they allowed the water from the spout to flow back over the mouthpiece. Frequently the water pressure was too low to produce a strong stream, and this made it impossible to get a drink without placing the mouth on the fountain head. The new fountains are so constructed that the water is held at an angle. This prevents the water from trickling back onto the mouthpiece. Instead, the water falls away from the mouthpiece. The new fountains also contain a mechanism that maintains a good strong stream of water.

Private or public pools offer similar sanitary problems. They must be made of water-tight material such as tile and cement The bath houses should be kept clean. There should be strict regulations not permitting anyone to bathe without first taking a shower and washing the feet in a dilute solution of disinfectant All swimming suits used should be clean This is difficult to control unless the bathers be made to use only those suits (rented) furnished by the management of the pool Health regulations usually demand that these suits be thoroughly clean and sterilized after their use All persons who have any evidence of a cold or skin infection or disease of any kind should be restrained from using the pool The water should be changed daily or weekly, depending upon the size and use of the pool. Pools that have continuous running water do not need such frequent cleanings. In most cases they are emptied every few weeks and cleaned Some public pools have a device through which additional chlorine may be added to the water. During the outdoor swimming seasons samples of the water should be taken at least twice a day and examined for the chlorine concentration and the presence of bacteria.

Public beaches and resorts include lakes, rivers, and the ocean. These are the responsibility of the state or local health departments. The sanitary problems are similar to those presented by swimming pools. However, the restrictions need not be so severe. The beaches should be kept clean and the water tested every few days.

If, for any reason, public beaches, resorts, or swimming pools fail to meet the health standards, they should be closed until such unsanitary conditions have been remedied.

One article of food that is frequently overlooked as a source of infection is ice. Just because it is cold and frozen does not mean that it is free from disease germs. Freezing may kill some of the pathogenic bacteria, while it merely inactivates others. When the ice melts, these quiescent bacteria become active and begin to grow, and if ingested they may cause disease.

Ice may be natural or artificial.

Natural ice is ice removed from frozen rivers, lakes, and ponds. It is stored in icehouses and kept until ready for use. Since this ice is made from lake water, it is subject to similar sanitary regulations. Before this ice can be used or sold to the public, it should be examined by the public health laboratory.

Artificial ice is water produced by refrigeration. It has already been purified by the water department. The only precaution necessary is to prevent contamination of the water, pipes, and containers used in the freezing process. Frequent inspections of the ice plant should be made by the sanitary engineer.

HOME SANITATION

Introduction.—Present-day modern American homes are safe against diseases that once scourged more primitive settlements. Early homes were without glass windows, wood floors, and chimneys. They were teeming with flies and insects and filled with dust, smoke, and dirt. Light was obtained from the fireplace. They did not have pasteurized milk, refrigeration, purified water, or modern toilets. Such inconveniences and lack of sanitation still exist in many of our tenement housing districts and rural areas. They constitute a definite health hazard. The houses and apartments are of poor construction,

unsafe, and overcrowded. In general, poverty, undernutrition, sickness, and death are associated with poor economic status. Through Federal Government aid and private enterprise, the state, city, and rural areas are gradually replacing slums with decent low rental homes and apartments.

Structure.—From a public health standpoint, house construction must be carefully planned and the materials used must be of good quality. The materials (brick, wood, pipes, roofing, etc) must ensure warmth, safety, fire protection, light, and durability.

Most localities have zone and building laws which place restrictions on the size, height of the building, materials used, distance between buildings, and number of families per house.

Plumbing.—Most communities have laws which permit the use of only certain types of materials. In the case of pipes, their qualifications must be met before a connection can be made with the water supply and sewer system. The first pipes used were made of lead These were unsatisfactory since they were pliable and this tended to cause leaks. They are forbidden by most communities. Iron pipes are frequently used, but they are troublesome since they rust inside and with time become clogged. The most satisfactory materials to use for plumbing fixtures are brass, copper, or nickel which, however, are more expensive.

For sanitary reasons and convenience, all plumbing fixtures such as valves and turnoffs should be exposed and in accessible places. *This permits easy repair and avoids accidents.*

All the pipes that carry waste water must be made of good resistant material. Of particular importance is the construction of the connection of the pipes in the toilet bowls. The pipes leading from the toilet bowls are joined together in the form of an "S". This is called a "trap" and serves to hold water in the base and to prevent escape of bad odors from the drainage pipes.

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a variety of proteins such as fresh meat, eggs, and milk. In the intestinal tract proteins are acted upon by the gastric juices, and amino acids are formed which pass through the intestinal wall into the blood stream. In the body these amino acids rejoin and form the proteins necessary for the function and formation of the various body tissues (albumin, globulin, muscles, lungs, liver). Because of this action, amino acids are called the building stones of tissue. There are twenty-two amino acids. Proteins are also oxidized in the body to supply heat and energy.

Carbohydrates.—These are excellent foods for providing the body with energy and strength. In the gastrointestinal tract the complex sugar molecules are broken down into simple sugars that can be utilized by the body tissues. Sugars are composed of carbon, hydrogen, and oxygen. When oxidized in the body, they are broken down into carbon dioxide and water. Glucose is the form of sugar carried in the blood and used by the body tissues. Glucose is stored in the liver and muscles in the form of animal starch or glycogen. The main sources of carbohydrate are vegetables, fruit, meat, and plain cane sugar used in cooking.

Fats.—Fats pass through the intestinal wall in the chemical form of glycerol and fatty acids. They are composed of the same elements as carbohydrates, carbon, hydrogen, and oxygen. Fats provide the body with a source for strength, energy, and heat. Since fats can be stored in the body as adipose (fat) tissue, they are a good reserve food to be used when the body needs extra nourishment and energy The body can manufacture carbohydrate from fats and synthesize fat from carbohydrate Certain fatty acids such as linolenic and linoleic are necessary for good health. An ordinary diet of such foods as egg yolk, meat, butter and cream contains a high per cent of fat.

Minerals.—Minerals such as chlorine, sodium, potassium, magnesium, iron, sulfur, copper, and iodine are found in most of the body tissues as organic and inorganic compounds. Minerals have multiple functions; for example, iodine is essential for the formation of thyroid hormone which controls and regulates body metabolism and growth, iron is necessary for the formation of hemoglobin, calcium is necessary for the proper

CHAPTER 33

NUTRITION AND FOOD CONTROL

NUTRITION

Nature produces all the foods necessary for the dietary needs of the body. Examples of natural foods are milk, vegetables, fruits, shellfish, and meat. All these foods contain chemical compounds required for a good diet. Food is utilized by the body for the production of body energy and to promote growth, to repair tissue, and to regulate other metabolic processes. In general, the important food substances may be classified as proteins, carbohydrates, fats, vitamins, minerals, and water. However, the present-day modern classification is concerned with the breakdown of these substances in the gastrointestinal tract into other substances or products which in turn pass through the wall of the digestive tract. Such products beside water are amino acids, which result from protein digestion, simple sugars, fatty acids, and glycerol which results from fat digestion, minerals, and vitamins.

Water.—Water is one of the most important foods It does not supply nutrition in the same sense as do the other foods, but its functions are so variable and necessary that lack of water soon produces severe maladjustment of the body (dehydration). Water is used in association with enzymes in the chemical breakdown of the complex molecules of proteins, carbohydrates, and fats. It acts as a diluter and solvent for substances in the gastrointestinal tract which facilitates their passage through the mucous membrane. Water makes up two-thirds of the body weight and is found in all the tissues and liquids (blood and lymph) of the body.

Proteins.—Body growth and tissue repair would be severely hampered without proteins in the diet. A good diet includes

ness requires a much longer time than normal for his eyes to adapt to the dark. The blindness is due to the loss of visual purple substance which requires vitamin A for its function.

Xerophthalmia is dryness with inflammation and ulceration of the conjunctiva and cornea. The tear glands fail to produce enough liquid and this causes drying of the eyes. This promotes bacterial growth which in turn produces ulceration.

There are now fourteen different known vitamin B compounds. For simplicity, they are termed vitamin B complex. The three vitamin B compounds most important to man are thiamine chloride (B_1), riboflavin (B_2), and nicotinic acid (niacin). These vitamins are water soluble. They are essential for growth, good digestion, carbohydrate metabolism, and maintenance of the epithelium. Lack of vitamin B_1 produces beriberi, a disease in which there is weakness, cardiac disturbance, edema (swelling of the tissues), and peripheral neuritis.

Lack of vitamin B_2 is usually associated with ariboflavinosis and pellagra. Ariboflavinosis is characterized by soreness with cracking at the corners of the mouth (cheilosis), increased number of blood vessels in the cornea, sore, red tongue, and greasy skin over the nose. Pellagra is characterized by a skin eruption (dermatitis), diarrhea, digestive upset, delusions, soreness and redness of the tongue and mouth, and weakness. These deficiencies are particularly common in alcoholics.

Thiamine chloride, riboflavin, and nicotinic acid are found in citrus fruits, turnip greens, green peas, tomatoes, green corn, strawberries, and cucumbers. A deficiency of these vitamins produces scurvy. It is characterized by lassitude, pains in the joints and muscles, shortness of breath, bleeding gums, ulceration of the gums, small hemorrhages in the skin and mucous membranes, anemia, and weakness Scurvy was a common disease among the early settlers and sailors. It is still found among the poor.

Vitamin D is fat soluble and is found in high concentration in cod-liver oil, egg yolk, liver, and milk fat. Deficiency in vitamin D results in rickets. When rickets occurs in adults, it is called osteomalacia. Vitamin D is also essential for the formation of strong teeth and bones. This is so because it controls calcium metabolism.

Vitamin E is an antisterility vitamin. It is also called tocopherol. It is a fat-soluble, stable compound. Deficiency

growth and formation of bones and coagulation of the blood; chloride, sodium, and potassium are necessary for keeping the concentration of water in the tissues and cells within normal limits. The mineral needs of people differ. Adults require smaller amounts of mineral elements in their diets than do growing children and expectant and nursing mothers. Most vegetables and meats contain a high per cent of mineral salts providing the soil is not deficient. The soil in the Great Lakes area is low in iodine content; therefore the incidence of goiter among its population is high.

Vitamins.—These are complex proteinlike substances that are necessary for good health. Normally, the body needs vitamins in very small amounts. If vitamins are lacking from the diet, the body stores soon become deficient and vitamin deficiency results. Vitamin deficiency results from (1) improper preparation of food which destroys the vitamins, (2) a diet low in vitamins, and (3) increased body demand for vitamins due to illness, pregnancy, growth, and lactation.

Vitamins are divided into two groups, based upon their solubility in water or fat. The water-soluble vitamins are B and C, while the fat-soluble ones are A, D, E, and K.

Vitamin A is found in animals and their products such as butter, liver, egg yolks, fat, and cod-liver oil It is fat soluble and colorless It is not found in plants. Plants contain carotene which is a yellow pigment. When animals ingest plants, their bodies are able to use carotene in the production of vitamin A. Carrots are very rich in carotene. This vitamin is necessary for growth, healthy skin, healthy mucous membranes (epithelium), and formation of the visual purple of the eye. When the body stores become deficient in vitamin A, night blindness, dryness of the skin, inflammation of the conjunctiva, corneal ulceration, breakdown in the mucous membrane lining of the gastrointestinal and respiratory tracts, cornification of the skin, decrease in growth, and weakness appear.

Night blindness (nyctalopia) is failure of vision at night or in dim light. It is more noticeable after the eye has been exposed to a bright light. A physiological form of it is the difficulty one has seeing when first entering a movie theater on a bright sunny day. An individual suffering from night blind-

individuals and the kind of food to be preserved. The latest methods are, refrigeration, smoking, pickling, salting, drying, canning, and chemical preservation.

FOOD CONTROL

Contamination of food is prevented by a strict sanitary code which controls the handling, processing, storage, and shipment of food. Any slip in sanitation risks contamination or spoilage. The need for close supervision in restaurants and factories, or any place where food is handled, is of the utmost importance.

A food handler is anyone who handles food in any shape or form or stage of production even to cooking and serving. All food handlers should have a thorough physical examination before being employed. Periodic examination should be given to make sure disease is not present Many large industries have installed mechanical devices for handling food, thereby decreasing the chances of contamination

Also important is supervision of the buildings where food is handled, stored, packed, and packaged. Food should be protected from dust, bacteria, flies, insects, rodents and household pets. This is particularly true when canning vegetables and meats and when making ice cream and butter. Bulk products have been replaced by the use of cans, jars, bottles, wax paper cartons, and cellophane wrappers All these give added protection against contamination

The methods of transportation of food by such devices as freight cars, ships, motor trucks, and airplanes have little to do with contamination or spoilage. Exceptions to this are seafoods and fresh fruits. The method of storage used in the transportation vehicle is important. Today the storage space of the freight cars, motor trucks, and ships are air conditioned and rat proof. Cargo planes are equipped for fast delivery of small quantities of frozen foods and articles that spoil rapidly or deteriorate under any circumstance, such as fish.

Food Adulteration.—Before the enactment of laws making adulteration of food a crime, it has been said that about 50 per cent of all processed foods were adulterated with cheaper materials. In some cases, adulteration of food is harmless, but if the adulteration decreases the nutritive value of the

the rat produces sterility. In the male rat the spermatozoa ;, while in the pregnant female rat the fetus is resorbed. At esent no deficiency in man has been proved. This vitamin is ind in abundance in wheat germ oil, lettuce, and meat.

Vitamin K is a fat-soluble compound. It occurs in alfalfa m which it may be removed. Many drug firms manufacture synthetically. This vitamin is essential for the production prothrombin which is necessary for the coagulation of the iod. Diseases that involve the liver, such as obstructive jaune, prevent the absorption of vitamin K from the gastroestinal tract. For vitamin K to be absorbed, bile must be esent in the digestive tract. When reduced in amount, there in turn, a reduction in the formation of prothrombin which ds to *an increase in the time that it takes blood to coagulate* tendency toward hemorrhage.

There have been recent discoveries of several new vitamin ompounds. Folic acid and B_{12} have been used in the treatnt of pernicious anemia with good results Vitamin B_{12} proved to be the more valuable of the two. Also discovered re recently are B_{13} and B_{14}. Their uses and properties are to be determined.

The role of diet and nutrition are important to good health only for the individual but for the entire nation. Many ple have poor eating habits, even where food is in ample ply. Poor diet lowers body resistance, and the effects are ı in lowered resistance to communicable diseases. Other ciencies also become apparent such as simple goiter, scurvy, ets and beriberi. If dietary deficiencies continue for a long od of time, changes appear which may affect the entire ; for instance, smaller stature

reservation of Food.—Several factors have brought about necessity for preserving food Some of these are as fol-s: (1) Some foods are seasonal so preservation is necessary eep them on hand for the future when they are out of on. (2) It may be desirable to keep food from spoiling. Man's taste for a variety of foods makes it desirable to erve food for transportation over long distances.

he oldest methods used for preserving food are salting drying of meat and fish. Now a great variety of methods in use. The method used depends upon the taste of the

of a diseased animal or from an animal which has died by some means other than slaughter; if the container such as a paper carton or tin can contains any substance which may affect the contents and make it injurious to health; if any valuable portion has been removed, such as cream omitted from milk; if any material has been added as a substitute (for example, cane sugar for maple sugar); if an inferior product has been concealed (for example, bleached flour); if any material has been added to increase the weight or bulk; if the material is a confection (candy) and it contains such substances as alcohol or something that lacks food value or if it contains a coal-tar product not certified by the Secretary of Agriculture.

The Federal Food, Drug, and Cosmetic Act considers a substance misbranded if it has a false or misleading label; if sold as another food; if the article is an imitation and the word "imitation" is not on the label; if the container is misleading in its size; if the package does not bear the label of the packer, distributor, or manufacturer; if any other word, statement, or information required by this Act does not appear on the label and is readable and easily understood; if it does not bear a label stating that the contained article is below standard; if the label does not have the name of the contained food or its ingredients (spices, colorings, etc.); if the contained food appears to be food that meets the standard prescribed by the Secretary of Agriculture, yet it does not meet such standards or bear the name of the food as specified by the standard; if the label on food for special diets fails to bear information concerning the vitamin, mineral, and other properties; and if the label does not contain a statement concerning the addition of artificial coloring, artificial flavoring, or chemical preservative

The Federal Food, Drug, and Cosmetic Act is enforced by the United States Department of Agriculture It has authority over products imported or transported from one state to another in interstate commerce.

Each state protects its population by special state laws similar to those of the Federal Food, Drug, and Cosmetic Act. These are enforced by the state officials Some cities set up their own local standards for such products as milk and butter.

food or adds some substance that is poisonous or produces infections, it constitutes a threat to health. Good examples of food adulteration are the addition of water to milk with or without removal of the cream, mixing of horse meat with ground beef or pork, adding cornstarch to cocoa, adding some coloring matter to restore the natural appearance of meat, and the selling of refined peanut or cottonseed oil as Mediterranean olive oil.

The Federal Food, Drug, and Cosmetic Act (Pure Food Law). —Laws governing manufacture of foods do not prevent the production of cheap or second-grade foods. Second-grade foods must be sold as such and not placed on the market for the public to buy as first grade. Any food or product manufactured that is not classified as first quality must also be clean and wholesome and contain a standard amount of food value. It is well to have such foods on the market, for they are inexpensive as well as nourishing; for example, condiments such as catsup, which is not eaten for its food value, may be made from tomato skins which may be almost as tasty and good as catsups made from the inside of the tomato. The important points here are: (1) skins used must be clean and sterilized, (2) preparation must be sanitary, and (3) catsup must be properly labeled as a second-grade product. Frequently the grading of foods such as fruits is not based upon the food value but upon the size, for example, a small peach has the same relative food value and quality as the large peach.

In 1906 the Federal Food and Drug Act was enacted for the purpose of preventing food adulteration and enforcing food control. It helped reduce the fraudulent practices in the marketing of foods and drugs to a certain degree, but certain legal loopholes persisted. So in 1938, the Federal Food, Drug, and Cosmetic Act with rigid regulations was passed by Congress. This Act prohibits the adulteration or misbranding of any food, drug, or cosmetic

The Federal Food, Drug, and Cosmetic Act of 1938 considers a food to be adulterated if any substance is added which might be injurious to health; if it is in any way putrid, decomposed, or filthy; if prepared or packed under unsanitary conditions which may permit contamination; if any part is a product

Mother's milk is the best food for all newborn infants. supply mother's milk for malnourished or premature infar most hospitals keep a milk bank. Mothers who have lost th babies or who have an oversupply of milk donate their m for the use of the hospital.

A growing child should have at least one quart of mill day. Adults should consume not less than one pint per d These dietary requirements can be fulfilled either by drinki milk, using it on breakfast foods, or by eating milk produ such as ice cream and cheese.

Besides being one of our most important foods, milk is a one of the most suitable vehicles for transporting and spre: ing disease germs. Before the development of pasteurizati *many epidemics could be traced to milk.* Milk *is not e* to keep clean and sanitary It is a suspension of many sm particles in water, and this is suitable for hiding small partic of dirt and bacteria. Unless it is kept cool, it is an excell medium for the growth of bacteria. This must be remembe when storing milk that is to be transported any great dista (farm to the city), and when bottling raw or pasteurized m It is essential that sanitary methods be employed. A cool te perature prevents the growth of bacteria Protection of m against contamination is especially important because m of it is consumed raw

Milk may become contaminated with two types of bacter pathogenic and nonpathogenic. The nonpathogenic bact are harmless when ingested. In milk they will grow and ca putrefaction and fermentation. Putrefaction results from breakdown of the milk protein through bacterial action. M that has undergone putrefaction is alkaline and has a bi taste. When ingested, it may cause a gastrointestinal up Fermentation is a result of the lactic acid bacillus acting milk sugar which is broken down into lactic acid and ca the milk to taste sour.

The pathogenic bacteria that have been spread thro milk are numerous. Most of them produce communicable ‹ eases. Because of the wide use of milk as a food, it can rea be seen how infected milk when served to families can st an epidemic Such epidemics are said to be "milk born It is essential that the cows and the milk handlers be free fr any communicable diseases. Dysentery, septic sore thr

In 1938 a Federal Law was passed, making it unlawful to advertise false statements or claims for the purpose of increasing sales of certain foods, drugs, cosmetics, or devices. This law is enforced by the Federal Trade Commission.

Food Sanitation.—Milk, milk products, meat, fish, and vegetables are the foods most commonly found in the diets of Americans. This makes the sanitary control of the production of food of vital importance to the health of the nation.

Milk: To show how important milk is for the health and growth of infants and children, it may be well to compare the dietary conditions in the United States with those of Korea, China, and Japan, where the war took away most food resources. In these foreign countries most children are breast fed so they receive all their nourishment (calcium, vitamins) from the mother who, in turn, is sacrificing her health because of the lack of food. Mothers who fail to produce enough breast milk rely upon the milk of goats or cows. However, these animals are scarce so the children frequently go hungry. Very little need be said as to how much our country differs from the Far East. "Ours is a land of plenty." Prior to the early Colonial days most of the milk was obtained from goats and a few cows. Following the arrival of more settlers, permanent communities were set up. This in turn brought about the need for more food, especially milk, so more cows were brought into the country and the dairy industry was born The dairy industry has increased in size until it has become one of the country's leading industries. In 1940, the United States Census Report stated that 619,000 dairy farms produced milk.

The annual consumption of milk and its products (cheese, butter, cream) is enormous. Each individual consumes, on the average, a total of 60 gallons, or 480 pounds, of milk and its products each year. Some 10 of these 60 gallons are milk.

Milk is one of our most nourishing foods. It is the best food available for infants; however, its iron and vitamin C content is low. To make up for these deficiencies, these two substances must be added to the milk when used for infants or an adult who is placed on a strict milk diet. Fortunately most infants are born with a high storage content of iron and vitamins obtained from the mother. This gives the infant a sufficient amount for the first few months of life.

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A growing child should have at least one quart of milk a day. Adults should consume not less than one pint per day. These dietary requirements can be fulfilled either by drinking milk, using it on breakfast foods, or by eating milk products such as ice cream and cheese.

Besides being one of our most important foods, milk is also one of the most suitable vehicles for transporting and spreading disease germs. Before the development of pasteurization, many epidemics could be traced to milk. Milk is not easy to keep clean and sanitary. It is a suspension of many small particles in water, and this is suitable for hiding small particles of dirt and bacteria. Unless it is kept cool, it is an excellent medium for the growth of bacteria. This must be remembered when storing milk that is to be transported any great distance (farm to the city), and when bottling raw or pasteurized milk. It is essential that sanitary methods be employed. A cool temperature prevents the growth of bacteria Protection of milk against contamination is especially important because much of it is consumed raw.

Milk may become contaminated with two types of bacteria: pathogenic and nonpathogenic. The nonpathogenic bacteria are harmless when ingested In milk they will grow and cause putrefaction and fermentation. Putrefaction results from the breakdown of the milk protein through bacterial action Milk that has undergone putrefaction is alkaline and has a bitter taste. When ingested, it may cause a gastrointestinal upset Fermentation is a result of the lactic acid bacillus acting on milk sugar which is broken down into lactic acid and causes the milk to taste sour.

The pathogenic bacteria that have been spread through milk are numerous. Most of them produce communicable diseases. Because of the wide use of milk as a food, it can readily be seen how infected milk when served to families can start an epidemic Such epidemics are said to be "milk borne." It is essential that the cows and the milk handlers be free from any communicable diseases. Dysentery, septic sore throat,

diphtheria, typhoid and paratyphoid fever, tuberculosis, undulant fever, hoof and mouth disease, and scarlet fever may be spread through milk.

Milk sanitation and its control is the function of the local health department. Most communities have adopted the "Standard Milk Ordinance" as published by the United States Public Health Service. This Ordinance makes the local health office responsible for the supervision of milk production, labeling, and sanitary standards (cleanliness, purity). The sanitary officer is in charge of the inspection of the dairies. He must make regular inspections of the dairies, pasteurization plants, and milk-collecting stations. Inspections should include checks on the employees, equipment, construction of the building, and records by a veterinarian of proper tuberculin tests and vaccination of the cows. To simplify this routine inspection and to do away with differences in sanitary codes, most states have formulated state-wide milk sanitation regulations that are carried out jointly by the state health department and the State Department of Agriculture.

Pasteurization is a means of rendering milk free of bacteria. The milk is heated in a large container at a temperature of 60 degrees C. for thirty minutes. Following this process the milk is rapidly cooled to 10 degrees C One way of testing for the degree of pasteurization is to determine the amount of the enzymes phosphatase and amylase present. If these enzymes are found in pasteurized milk, the process has not been effective, for pasteurization should destroy these two enzymes.

Certified milk is milk that has been produced and sold under the specifications of a medical milk commission This commission is appointed by the local medical society It in turn appoints a doctor, veterinarian, laboratory director, and sanitary inspector who checks the plants of the dairymen who apply for permission to produce certified milk. While certified milk is the cleanest milk produced, it is still a high-grade raw milk. Unless pasteurized, certified milk is always a potential source of danger. To determine how clean (bacterial free) milk actually is, bacterial counts are made. The milk commission sets a standard of a maximum of 10,000 bacteria per cubic centimeter for certified raw milk If pasteurized, it cannot contain more than 500 per cubic centimeter. The speci-

fications set for the number of bacteria per cubic centimeter in other milk depends upon the sanitation rules in the different cities. Generally the maximum number of bacteria varies between 100,000 and 200,000 before pasteurization. After pasteurization, the milk cannot contain more than 30,000 bacteria per cubic centimeter. Not only the number but also the kind of bacteria in milk is of importance. A large number of nonpathogenic organisms is less important than a small number of pathogenic bacteria such as typhoid bacilli.

Most states have a system whereby milk is classified in different grades of quality, depending upon the number of organisms present on a bacterial plate count. It is classified as Grade A, B, C, or D milk.

Grade A milk must be produced under the sanitary code regulations of the state. It may be sold as pasteurized or raw milk. If raw, it must not contain more than a bacterial plate count of 50,000 bacteria per cubic centimeter. After pasteurization the bacterial plate count must not exceed 30,000 bacteria per cubic centimeter.

Grade B milk must be produced under the same sanitary regulations as Grade A milk The difference is in the number of bacteria present per cubic centimeters of milk. Raw milk may contain a maximum bacterial plate count of 300,000 per cubic centimeter. Pasteurized milk may contain no more than 50,000 bacteria per cubic centimeter

Grade C milk is a milk of poor quality. Raw milk must not exceed a bacterial plate count of 1,000,000 per cubic centimeter.

Ordinary milk contains a very small amount of vitamin D. To overcome this defect, three different methods are used to increase the amount of vitamin D in milk They are irradiation, feeding irradiated yeast to cows, and fortifying milk by the addition of vitamin D concentrate. All grades of milk (homogenized, certified, A and B) except Grade C can be used to make vitamin D milk.

Homogenized milk is of uniform quality throughout. This is obtained when milk is emulsified under high pressure. The emulsification produces a fine suspension of tiny fat globules. This produces a soft curd that makes it easy to digest. This type of milk is excellent for children.

Since many foods, including cheese, butter, and ice cream, contain a high per cent of milk, they, too, may be a potent

source of infection if infected milk is used. It is essential that these industries be required to adhere to the same sanitary regulations set up for the dairy industry.

Keeping milk free from contamination is not a simple process. There are numerous chances of pollution as the milk travels from the farm through the dairy to the consumer. To prevent this requires control of all the factors that may affect the quality of the milk.

In general, milk sanitation is concerned with:

1. Source of the milk—The cows must be healthy, free from undulant fever and tuberculosis.
2. The farm supplying milk to the dairy must have clean cow sheds, separate from those of other animals.
3. All equipment and utensils used in the handling of milk must be scalded or sterilized after usage.
4. All milk handlers and milkers must be free from communicable disease.
5. All milking must be done under sanitary conditions.
6. Bottling and capping of milk must be done in a sanitary method with frequent sanitary checks on the machinery and pipes.
7. Milk must be pasteurized.
8. The milk must be kept cold during its transport from the dairy to the neighboring city All local milk stations must be equipped with refrigeration for proper storage of milk collected from the farms.
9. Milk must be checked by a bacteriologist
10. Quality of milk must be determined by a chemist.
11. Qualified sanitary engineer must be available
12. Qualified dairy engineer must be available.
13. Physical examination of new employees by a physician —should include a nose and throat culture, stool specimen, and Wassermann and Widal tests. Periodic examination of all employees.
14. A veterinarian to inspect and care for the dairy cows.
15. Proper refrigeration of milk in all grocery stores or places selling milk and vehicles delivering the milk to the consumer.

Remade, Condensed, Evaporated, Dried Milk: Remade milk is a homogenized product made from a mixture of milk powder

(dehydrated skimmed milk), unsalted butter or milk fat and water. It is a good substitute for fresh milk and differs very little in taste. It is clean with a low bacterial count. It is very nutritious.

Condensed milk is milk made by removing part of the water by evaporation. It is pasteurized and preserved by adding 40 per cent cane sugar.

Evaporated milk is milk condensed without the 40 per cent sugar. The milk is preserved by sterilization.

Dried milk (milk powder) is made by drying milk through a vacuum process or spraying into a hot tank containing hot, dry air. This type of milk contains all the food value of fresh milk, but some vitamin C has been lost.

The United States Government Standards require that each of these last three prepared milks contain a certain per cent of milk solids. The chart below shows these figures and their comparison with each other.

	TOTAL SOLIDS	MILK FAT
Fresh Milk	12 %	3.25%
Condensed Milk	28 %	8 0 %
Evaporated Milk	25 5%	7.8 %

Cream, Skim Milk, Butter, Cheese.—Cream is the fat part of the milk. It is the pale cream-colored solution that floats on top of the milk. It must contain at least 18 per cent fat.

Skimmed milk is the milk left behind after the cream has been removed. It has a high nutritive value. Most communities do not permit skimmed milk to be sold lest it be used as a substitute for whole milk.

Butter is made by churning sweet or sour milk. The taste varies with the addition of salt and flavoring. The liquid that is squeezed out by the pressure produced during churning is called buttermilk. Its flavor is "sharp" due to the large number of lactic acid bacteria it contains

Cheese is made from the solid particles in milk curd Most cheeses are rich in protein, carbohydrate, fat, and mineral salts. The great variety of flavors results from the different molds, bacteria, and enzymes used in the ripening process.

Meat and Fish: Meat and meat products are inspected by the sanitary officers of the Federal, state, and local health agencies Since most large meat-packing houses prepare meat for interstate shipment, the sanitary inspection is done by

Federal meat inspectors. In 1906 Congress passed the Meat Inspection Act placing meat inspection under the Department of Agriculture. The administrative functions are handled by the Bureau of Animal Industry. This Act made it compulsory that all animals (cattle, sheep, goats, swine) be inspected prior to slaughtering if the meat was to be shipped outside the state or to a foreign country. Later on, 1919, horses were included, and inspection was required of horses slaughtered for meat. All animals that failed to meet the requirements and were rejected by the inspector had to be slaughtered and disposed of immediately. Meat that passes the inspection receives a small purple stamp of approval which reads, "U.S. Inspected and Passed." This denotes government inspection. Also included in the Meat Inspection Act were sanitation regulations. These functions were carried out by the inspector and included the proper method of preparing meat, refrigeration and marketing, storage facilities, and sanitary equipment. The state and local public health units usually employ their own veterinarians to inspect the meat. The sanitary officer is responsible for the proper handling of the meat, storage and refrigeration, marketing, and inspection of retail and public markets.

Fish, lobsters, crabs, shrimps, oysters, and clams may inhabit shallow water which makes them likely to carry pathogenic bacteria. This is particularly true of fish obtained from shallow water located near the sewage disposal pipes that drain into that body of water.

Fish obtained from large rivers, lakes, or the ocean far enough away from any polluting sewage are usually clean. The main sanitation requirements for these fish are proper storage in clean vaults and refrigeration.

The diseases spread to man by infected meat and fish are usually parasitic, such as trichinosis and tapeworms. Non-parasitic diseases include typhoid fever, botulism, and tuberculosis.

CHAPTER 34

SEWAGE AND GARBAGE DISPOSAL

Supervision of the disposal of sewage is the *responsibility* of a trained sanitary engineer employed by the health department. Most large cities have their own public health engineer. Smaller communities usually receive aid and supervision from the public health engineers of the state health department. Not all cities or communities use the same sewage or garbage disposal methods. Only the more common types will be discussed. Proper disposal of sewage is essential for good health. Most cities have regulations that do not permit improper handling of waste products and refuse. When these products are allowed to accumulate, they become sources of disease (cholera, typhoid fever, amebic and bacillary dysentery, and parasites).

Disposal of Human Wastes.—Sewage is a term covering the waste products of man such as excreta (feces and urine), water drainage from the bath tubs and sinks, and waste discharges from factories. Sewerage refers to a system of pipes that carries the sewage. The sewer pipes usually enter into the nearest large body of water or lake, river, or sewage disposal plant. Most cities have a second sewer system that drains the wastes from the street. As a general rule, these two sewer systems are combined. The liquid part of sewage is called "effluent"; the solid portion which settles out is called "sludge."

For convenience and clarity, the methods of disposal of wastes in the city or urban areas and rural districts will be discussed separately. In cities near the seashore or rivers, sewage may be disposed of by direct emptying of the sewer pipes into a large body of water Since most cities so located use this water for drinking and cooking, this method is not

justified. To prevent disease, some method of purification of the sewage is necessary and so is purification of the water as already described. In rural districts and on farms excreta are carried off into cesspools or discharged into privies. In the woods and during camping trips, excreta is discharged into a small hole and then covered with dirt.

In large cities a sewerage system is used to remove the sewage from the home or factory and carry it to a large basin or to a disinfecting plant, where it receives treatment. These types of sewage disposal include purification either by chemical or bacteriological methods. Chemical purification requires the use of a strong chemical such as chloride or caustic soda which is added to the sewage. This method is most commonly used in tourist camps. A tank called a chemical closet that holds the chemical is placed under the toilet seat. When the excreta falls into the tank, the chemicals partially dissolve the material.

Bacteriological purification is carried out under two different processes. These are the aerobic (oxygen present) and anaerobic (oxygen absent) methods.

The aerobic methods are four: sewage farming, intermittent sand filtration, sprinkling filters, and activated sludge. The proper working of an aerobic method depends upon the presence of enough oxygen so that the bacteria in the sewage can act upon the nitrogen substances and form nitrates. During this breakdown process large amounts of carbon dioxide are formed. Upon completion of the breakdown, the solid residue that is left is called the sludge

Sewage farming has been used in some small communities but is not entirely satisfactory The method consists of running the sewage onto soil that is either gravel or sand and allowing it to settle. The liquid part soaks through the gravel or sand into the dirt and deeper into the underground streams. The filtration practically clears the solution of bacteria The solids left on top remain as fertilizer.

Intermittent sand filtration consists of a filtering bed of sand which has as its support an underlying bed of gravel, rocks, and tile so placed as to permit freedom of drainage. The sand bed is covered with sewage to a depth of several inches and then allowed to dry. The next layer of material is added within a few hours. The interval of time between the addition

of the sewage permits the sand particles to become coated with a gelatinous substance produced by the oxidizing bacteria. This gelatinous coating and the oxidizing bacteria increase the efficiency of the filtering process so that 99 per cent of the bacteria are removed. The water led off from the base of the sand filter is clean and almost pure. The main factor is the interval of time between the additions of the sewage. Since the oxidizing bacteria are of the aerobic type, they require oxygen. So between filters the oxygen in the air must be allowed to penetrate the filter bed. Such a filter bed one acre in area can filter 100,000 gallons of sewage per day.

Sprinkling filters consist of a filtering bed made of broken stone, coke, or coal. The floor of the filtering bed is made of concrete with a drainage system. The stones are laid to a depth of about seven feet. Pipes with sprinkling nozzles are placed at various distances over the filter bed. The sewage is forced through the pipes and a spray produced. The spray accumulates oxygen from the air that helps the oxidizing process of the aerobic bacteria. As the spray falls, the oxidized material strikes the stones and sticks because of the action of the aerobic bacteria. The liquid passes on through the filter. This method removes 90 per cent of the bacteria.

The activated sludge method simply means the passing of bubbling of air through sewage held in a large tank As the air passes through the sewage the aerobic bacteria become attached to the sludge and cause a breakdown of the nitrogenous materials. The sludge settles to the bottom of the tank. This method removes about 90 per cent of the bacteria. The sludge left behind is a good fertilizer.

The anaerobic method depends upon the breakdown or decomposition of sewage by bacteria that will grow in the absence of free oxygen. When sewage is collected in large sealed containers, what little oxygen is present is first utilized by the aerobic organisms. But, in a short time, all the free oxygen is gone. In the absence of oxygen these bacteria die and only the anaerobic organisms remain. These bacteria obtain their oxygen from the decomposition of the organic substances in the sewage Proteins are broken down into three different gases: hydrogen sulfide, nitrogen gas, and ammonia. Carbohydrates are broken down into various products. The sludge that remains is tarry in consistency and has a putrid

odor. There are several anaerobic processes in use such as the cesspool, septic tank, and the two-story tank (Imhoff tank).

The cesspool consists of a pit that is lined with large stones The stones are so placed that they allow free seepage into the adjacent soil. This is also called a leaking cesspool. The solid substances of the sewage collect in the bottom of the pit. Within a short time, the bacteria in the sewage cause the solid portion to liquify. This reduces the volume of the sewage. After prolonged use it is necessary to remove the accumulated sludge.

The septic tank consists of a tightly sealed tank in which the sewage is collected. This is excellent for anaerobic action. Through bacterial action, gases are formed and the quantity of sewage is greatly reduced. The liquid that collects is usually covered with a scum This liquid is removed and carried through another purification process or it is piped off into a nearby river or large body of water From time to time the sludge must be removed and the tank cleaned.

The two-story or Imhoff tank is a large concrete tank approximately 30 feet deep. It consists of two chambers: an upper chamber for sedimentation and a lower chamber for digestion of the sludge The upper chamber is constructed in such a manner that it allows the solid part of the sewage to pass through a slot into the lower chamber In the lower chamber the sludge undergoes anaerobic decomposition which produces gas and a brown or black-colored material The gas is allowed to escape through side vents The sludge is removed and pumped into drying pits where it is allowed to dry. This dried sludge is used as a fertilizer.

Many cities have installed scientific sewage disposal plants which use a combination system of sprinkling filters and slow sand filtration. Others have used chemicals such as chlorine or calcium hyperchloride These chemicals are added to the effluent that is piped off to drain into the river or nearby lake. Since none of the previously mentioned methods removes all of the bacteria, the chemicals will kill those that might spread disease. In a good municipal sewage disposal plant the sewage passes through several steps: (1) screening or straining with an iron wire mesh screen to remove all sticks, clothes, etc., (2) sedimentation, which permits the solid particles to settle to the bottom (sludge), (3) decomposition of the liquid

portion (effluent) and sludge by aerobic or anaerobic bacteria, (4) removal of the bacteria by filtration, and (5) disinfection with chemicals.

The manner of sewage disposal in rural areas depends upon (1) whether water is piped into the building, (2) the financial circumstances of the people, and (3) their sanitary education and culture. Since many homes in the country lack piping facilities, their source of water has to be a well or water that has been carried in and stored in a large tank. Each home has its own source of water and method of disposal of waste. The disposal of human excreta must be handled with care so as to prevent pollution of the nearby water supply or contamination of the gardens and milk. It must be boxed in such a manner that insects (flies), rodents, and farm animals can not gain access to the excreta and spread the bacteria.

The most common methods used in the rural areas are the pit privy, borehole privy, surface privy, cesspool, and septic tank. All these constructions must be placed an adequate distance from the houses, barns, wells, and streams so as to prevent their contamination.

The pit privy consists of a deep hole dug in the ground and covered with a tight wooden closetlike structure which prevents the entrance of flies. The privy house must contain a door, lids that will stay closed when not in use, and screens over all openings to the outside. This affords both sanitation and privacy.

The bore-hole privy consists of a deep hole (20 feet deep) in the ground The hole has a diameter of 16 inches The hole is made with a posthole auger and is dug until a ground-water level is reached The privy house should be tightly sealed.

The surface privy is one in which the excreta collects on the surface of the ground. The liquid portion of the excreta is absorbed by the earth The construction of the base of the privy house must be tight, otherwise the excreta will leak out from the sides, permitting contamination of the surrounding soil, and will allow spread of disease by flies, rodents, and animals.

The cesspool and septic tank have already been described

In Korea, Japan, and China human excreta are collected from the privies and placed in wagons by men who then take

odor. There are several anaerobic processes in use such as the cesspool, septic tank, and the two-story tank (Imhoff tank).

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be discarded and burned or buried with the refuse. If such material is allowed to collect, it serves as a fire hazard or as a fly and rat breeding area and creates generally unsanitary conditions.

For home disposal of garbage, manufacturers of home equipment have made a grinding unit that fits into the drain of the sink. Food wastes are ground so fine that they can be washed through the sewer pipes without any danger of clogging.

the material out to the farmers and sell it for fertilizer. Such an unsanitary method of fertilization leads to a widespread contamination of all produce, which in turn spreads disease to the people. The incidence of parasitic diseases in these countries is very high.

Garbage Disposal.—Garbage by itself will not cause disease but it feeds flies and rats. When it begins to decompose, it produces a disagreeable odor.

A differentiation should be made between the terms refuse and garbage. Refuse is any worthless or useless material such as garbage or kitchen waste, ashes, street litter, lumber, and rubbish. Garbage is food refuse from the kitchen only.

The garbage should be collected in metal cans with tight covers. From time to time the can should be scrubbed clean and washed with hot water and soap. Most communities have garbage trucks that collect the garbage at frequent intervals. These trucks are especially constructed to prevent the escape of odor and exposure of the material. After the garbage is collected, it is usually taken to an incinerator camp or dumping area. At the incinerator camp the garbage is placed in a special pit and burned, after which it is covered with a thick layer of dirt. At the dumping area the garbage trucks are emptied and then cleaned. In some communities farmers are permitted to buy the garbage for hog feed. However, before the garbage is fed to the animals, it should be cooked to kill all parasites which may cause disease.

Such rubbish as bottles, tin cans, rags, and papers should be collected in a large metal container or pail. It should be emptied weekly. Most cities have separate trucks that collect this type of waste. It is taken to rubbish dumps where it is used as a "filler" to fill in swampy areas or where it is burned.

The litter removed from the streets by the street cleaners is collected in trucks and hand carts and disposed of at the rubbish dumps or by burning It has been a practice of most cities to wash the streets and sidewalks daily in the congested areas. This is a good sanitary practice as it removes all dirt from the streets.

The farmer has such wastes as cornstalks, weeds, leaves, manure, garbage, and other rubbish. He may save some of the manure for fertilizer, but that which is not needed should

All drinking fountains should be placed in locations easy to reach. The water should be kept cool. Since most water fountains are of the mechanical type, they should be checked at frequent intervals. A moderately strong stream of water is necessary to make the water accessible without contamination of the mouthpiece. If faucets are used, paper cups should be supplied. The cups should be kept in a sanitary dispenser attached to the wall or the side of the drinking fountain.

Washrooms should be readily accessible. The number of lavatories and toilets should be sufficient to prevent crowding. Some industries have shower bath facilities for those who do dirty work or work with materials which might irritate the skin, such as coal or mercury.

Rest rooms are supplied for those who are fatigued or who become indisposed while at work. They are usually located near the medical dispensary. Some industries have added a small rest room to the washroom. This is used by the employees during their rest period or over the lunch hour.

Lighting, heating, and ventilation are of equal importance. The light should be of the nonglare type that gives the optimum amount of illumination Poor lighting produces eyestrain which may cause defective vision and eventually lead to poor health. Insufficient light is also conducive to accidents. Heating and ventilation should supply warmth and fresh air so as to keep the employees comfortable. Most industries use the combined system of motor-driven fans that force fresh cool air into the rooms and at the same time exhaust fans which remove the foul air. The air should be kept at proper humidity, otherwise it becomes heavy and damp and makes the workers feel warm and uncomfortable.

Scientific research shows that noise is detrimental to the nervous system, hearing, and efficiency. Where noise cannot be reduced, as in machine shops, the workers can wear ear protectors made of wax, cotton, or soft rubber Ear plugs are satisfactory but their constant use may cause inflammation of the ear canals Many cities have put on campaigns to reduce noise caused by radios and car horns. Some have even passed city ordinances, placing a fine on anyone making unnecessary noise.

CHAPTER 35

INDUSTRIAL HYGIENE AND SANITATION

The health of the hundreds of thousands of people employed in industry is of vital importance to the welfare of the nation It involves both the large industry that hires 25,000 persons or more and the farmer with one hired man. Industrial hygiene and sanitation grew up with the Industrial Revolution. This change produced new problems between the employer and employee. Special management-labor boards had to be created to determine and regulate the number of working hours, hiring of women and children, salaries, and working environment (safety, sanitation, hygiene, toxicology). It has been shown that with good cooperation between the employee and employer, all problems can be met and handled to the benefit of both parties. However, too frequently one of the two parties forgets its responsibilities and fails to fulfill his part of the bargain

Industrial hygiene and sanitation may be best discussed by considering all the responsibilities that industry has and should maintain for the benefits of the employee. Industry cannot arrange its program to suit the individual. It is set up so as to benefit the group

For further reference, the reader should consult the outline of industrial hygiene by Turner He groups industrial hygiene into three phases (1) responsibilities of industry in maintaining hygienic working conditions, (2) health administration in industry, (3) governmental influence in industrial hygiene and sanitation

Responsibilities of Industry.--Nothing is more conducive to a happy environment and good work than clean surroundings in which to work. This requires adequate help to keep the walls, floors, steps, elevators, drinking fountains, rest rooms, and washrooms clean. To emphasize the advantages of cleanliness, display posters should be placed in places that the employee can easily see and read At the same time the employees should be educated in hygiene and sanitation.

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For efficient work, all environmental factors that may lead to fatigue should be removed. The first requirement is for the worker to have the proper amount of sleep. This depends upon the individual. Some people require more sleep than others. When at work for any length of time, physical and mental fatigue will develop. It is difficult to differentiate this from boredom. In most cases the fatigue of a day's work is relieved by a night's rest. Work that is dangerous or tedious and exacting is more fatiguing and should be limited to short hours of work with frequent rest periods. Efficiency experts have shown that one's accuracy decreases near the middle of the morning and afternoon. It has also been shown that the number of accidents increases during these hours. To reduce accidents and to increase efficiency, most industries now make use of mid-morning and mid-afternoon rest periods. Other factors that frequently contribute to fatigue are poor living conditions at home, poor habits (oversmoking, overeating, overdrinking), insufficient rest at night, improper lighting, improper ventilation, and poor working habits.

Lighting; Heating and Ventilation.—See p. 439.

Industrial Hazards and Poisons.—The types of hazards and poisons to which workers may be exposed depend upon the kind of industry under consideration: for instance, the coal industry does not have the same type of hazards to consider as the canning or automobile industry. Although industrial accidents are frequent occurrences, the incidence of accidents in the home is higher than that of industry.

Industrial hazards may be the result of working conditions, such as poor sanitation, improper lighting, improper ventilation, improper heating, poor construction of the building, improper arrangement of machinery, steps, etc.

If sanitary control is inadequate, it permits dirty washrooms, toilets, rest rooms, and drinking fountains. Infrequent checks on sanitation lead to a dirty environment and dissatisfaction of the employees. It permits the existence of defective wiring, leaky valves and pipes, and toilets and wash basins that are plugged.

Employees allowed to work in an environment of i lighting, improper ventilation, and improper heat so fatigued and are more likely to have acciden'

Buildings of poor construction and planning offer one of the greatest hazards. Numerous conditions may exist such as lack of safety devices for punching, cutting, and drilling machines, fan belts, elevators, stairways, compressors, and cranes; obstruction of aisles by improperly placed machines; narrow and steep stairways; a too small working area; and collection of waste on the floors, around the machinery and on the stairways.

Such conditions can be altered by the employer but not for long if the employees do not assist by carrying out the necessary safety precautions. Industry should have classes for teaching safety measures to assure itself a continuous reduction in absenteeism and manufacturing costs and, at the same time, to safeguard the employee. Industries that have safety education programs have reduced the accident rate 75 per cent.

Industrial infections result from dirt, dust, toxic metals, and bacteria. It is impossible to remove all the dirt and dust in industry. That which cannot be prevented can be removed by proper ventilation with exhaust fans over the machinery to suck out the dirt and dust as it is formed Another method is to wet the material and floor of the work shop. Workers exposed to air with a high concentration of dust become susceptible to diseases of the lungs For protection, such workers should wear special filter masks.

Not all dusts are alike. Some are made up of fine particles, while others are coarse. Those of fine particles are more harmful than those of coarse particles. The particles of fine dust are smaller and light and remain suspended in the air longer. Therefore, they can penetrate the airways of the respiratory system more easily.

The different kinds of dust may be classified according to the occupation involved:

1. Metallic dusts printers, grinders, polishers.
2. Mineral dusts: stonecutters, miners, cement workers.
3. Animal dusts: hatters, wool workers, carpet makers.
4. Vegetable dusts: weavers, flour millers, cotton and sugar workers.
5. Chemical dusts: leather tanners, mercury and lead handlers, oil and coal tar workers.

These dusts all differ in the type of injury which they inflict. Some of the dusts contain chemical poisons (lead, mercury), while others such as wool may contain disease germs (anthrax). The fumes and dusts from lead and mercury may affect the blood-forming organs. Inhalation of coal, flour and cotton dusts may cause injury of the lining of the respiratory tract. The chronic irritation caused by these dusts produces an overgrowth of fibrous tissue with scarring and loss of elasticity of the lungs. When this happens the disease is called pneumoconiosis. Stonecutters and marble workers are exposed to silica dust which acts as a mechanical irritant to the epithelium lining the respiratory tract. The tissue of the lungs responds by the formation of fibrotic scar tissue in the air sacs (alveoli). If there is no let up in the exposure to the silica dust, the disease silicosis develops. The symptoms are dry hacking cough, loss of appetite, loss of weight, and dyspnea. Because of the lowered resistance, the body is more susceptible to the tuberculosis germ, and there is a high incidence of tuberculosis in stonecutters.

Space does not allow a full discussion of all the poisons and infections that may occur in industry. Only a few of the more important and common toxic substances will be described.

Lead is an industrial poison with which industry has had to cope for many years. It is used in numerous industries such as plumbing, painting, welding, typesetting, and photography. Lead is most poisonous when in the form of soluble carbonates It gains entrance to the body through inhalation of lead dust, swallowing dust that is carried to the mouth on the hands, and absorption through the skin. Once lead becomes deposited in the tissues, it is difficult to remove Continued exposures will lead to an accumulation of the lead and soon to the development of symptoms When exposure is continued for many years, chronic lead poisoning develops. One of the first signs is a blue lead line on the gums. This is pathognomonic of lead poisoning Lead poisoning may occur in three forms, acute, mild, and chronic. When acute, the symptoms of severe abdominal pain, nausea, vomiting, and convulsions prevail. In the mild and chronic form, the main symptoms are weakness, constipation, anemia, sweet taste in the mouth, neuritis, nausea, and vomiting. A study of the red blood cells

shows an anemia and stippling of the individual red cells. The important safety measures are as follows: gloves should be worn, the hands should be washed before eating, and a shower bath should be taken after work. Antidotes are milk and magnesium sulfate.

Mercury poisoning is not as common as lead poisoning, but it is just as dangerous. Mercury is used in the manufacture of felt hats, fireworks, thermometers, and dental fillings. The symptoms of mercury poisoning are decrease in the output of urine (oliguria), skin rash, mental confusion and ulcerations on the gums. A good antidote is the white of an egg.

Arsenic poisoning may occur in individuals working in the fur and feather industry and chrome factories and in those engaged in spraying trees and plants with disinfectants to protect them against insects. Accidental poisoning may occur in individuals who are being treated for syphilis with arsenicals. Many rat poisons contain arsenic. When ingested, an acute gastroenteritis develops. Symptoms of arsenic poisoning are skin rash, nausea, vomiting, neuritis, and headache.

Radium poisoning is rare today since the proper precautions are now used to protect the worker. Radium is used in the watchmaking industry to paint the dials It is used by the doctors to treat cancer When not in use, radium should be kept in thick lead containers. The most common effects of radium are necrosis of body tissue

Phosphorus is used in the manufacturing of insecticides, fertilizer, fireworks, and matches. Early in the match industry white phosphorus was used, but this has been replaced by a nonpoisonous compound.

Benzol (benzene) is a distillation product derived from coal tar. It is commonly used as a solvent in industries that make shellac, lacquer, enamel, and rubber goods. It is a volatile liquid which enters the body through inhaled fumes The main symptoms are dizziness, headache, and neuritis. The organs that are most easily injured are blood-forming organs, liver, kidneys, and the nervous system.

Carbon monoxide poisoning is a frequent cause of death both in industry and in the home It is formed when there is incomplete combustion or burning. It is found in high concentration in the exhaust gases of automobiles Poisoning from carbon monoxide occurs most commonly in closed garages in

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The Personnel Department and Health Administration in Industry.—For the sake of efficiency large industrial plants are divided into several departments. Some of these are the sales, production, finance, health, personnel, and advertisement departments. It is through the cooperation of all these departments that large industries function. The two with which we are concerned are the departments of personnel and health. These two departments may function as separate departments or together as one unit.

The personnel division is under the supervision of an individual who is well trained and experienced in handling all or any problems that might affect the worker. He is called the personnel manager. His department is responsible for employment, education, health, working environment, and general welfare of the employee. Under the general welfare unit is included special help and advice on problems concerning loans, retirement plans, sick benefits, legal and personal aid, savings, and profit sharing. The health and sanitation section includes the medical, dental, and sanitary units. The training and education sections conduct special classes for those who are interested in increasing their efficiency and gaining a promotion. Through the use of special tests the vocational director is able to determine the type of work best suited for certain workers. Included are classes and lectures on dental and medical care, safety, sanitation, and health education.

The employment division is one of the most important units in industry. It is under the supervision of an employment manager. Before an employee is hired he must fill out numerous qualification blanks stating what training he or she has had. Following this he is interviewed to determine what line of work he is best able to perform. If the applicant is able to pass the physical examination given by the physician in charge, he is eligible for employment. Many industries use a medical classification for determining the type of work an individual may do. Class A means the individual may be hired to perform any type of work; Class B may mean the employee has some impairment of vision that cannot be corrected by glasses so he or she does not qualify for a position that requires long use of the eyes and detailed work such as operating a switchboard. However, there are usually many variations in the interpretation of the physical standards that

which there is a running car engine. When carbon monoxide is inhaled it combines with the hemoglobin in the red blood cells and prevents oxygen-hemoglobin combination. Within a matter of minutes the body is depleted of oxygen since the passage of oxygen from the lungs to the tissues is prevented. Unfortunately CO is an odorless gas which cannot be readily detected. The main symptoms are fatigue, dizziness, and headache.

Other substances classified as industrial poisons are nitric acid, chlorine, methyl alcohol, sulfur dioxide, phenol, naptha, and nitroglycerin.

The diseases most common to industry are anthrax, undulant fever, and tuberculosis.

Anthrax is caused by the organism *Bacillus anthracis.* It is spread to man through the handling of infected cattle. It gains entrance to the body by two routes: (1) abrasions in the skin and (2) inhalation. When the bacilli lodge in an open wound in the skin, they grow and produce chronic ulcers. In the lungs an inflammatory reaction develops that is similar to that of pneumonia

Undulant fever is caused by the bacillus *Brucella melitensis.* It is spread to man through direct contact or by ingestion of the products (meat, milk, etc.) of infected cattle, hogs, and goats. The incubation period is six to thirty days. The onset of the disease is insidious. It is characterized by irregular fever, sweating, chills, and pain in the muscles and joints. Control of the disease is managed through pasteurization of milk and elimination of infected animals.

Individuals working in a dusty environment are more likely to develop tuberculosis This is particularly true of workers of the laboring class and those living and working in crowded areas. The disease cannot be contracted from work or dust unless the organisms are present; however, some working conditions predispose to the development of the disease in that they lower body resistance To make an early diagnosis of tuberculosis, frequent physical examinations and periodic chest x-ray examinations should be made To decrease the incidence of tuberculosis in industry, several things should be provided, such as health education, good working environment, physical examinations, and chest x-rays.

If the patients do not understand the physician's orders, she must be able to make the necessary adjustments. She should be able to do the routine laboratory tests, carry out physical therapy, and operate the x-ray equipment. She should be able to take charge of the health program and make all the necessary arrangements for its promotion

Functions of the Government in Industry.—Only in relatively recent years has industry been held legally responsible for its employees. Prior to the passage of the child labor laws in Pennsylvania in 1848, industrial hygiene was unknown. Similar laws were soon passed in other states. In 1906 a National Committee on Child Labor was organized. In 1912 Congress placed the Children's Bureau under the Department of Labor. Some states have passed laws regulating the employment of children. These laws forbid the employment of children for night work, limit working hours, and forbid altogether the employment of children under a certain age. In 1938, the Fair Labor Standards Act was passed which set up standards for employment of children in industries that manufactured products for interstate commerce. The regulations are enforced by the Children's Bureau.

Along with the development of industry there was a gradual increase in the employment of women. This produced many new hygienic problems that had to be studied and solved. Since women do not have the strength of men and have a greater loss of time from work due to illness, certain allowances had to be made. For example, most states require a pregnant woman to stop work about four weeks before the expected date of confinement and require that she does not return to work until four weeks after the delivery of the child.

The year 1908 marks the beginning of the Workmen's Compensation legislation In 1910 New York passed similar laws but they were ruled unconstitutional The next year, 1911, ten other states passed laws for Workmen's Compensation. *During the next twenty-nine years, all but one of the forty-eight states enacted similar laws.* These compensation laws caused a change in the attitude of industry toward sanitation and welfare activities for the workers. The Workmen's Compensation regulations were confined to occupational injury. Nothing had yet been done about occupational disease. In 1919 Wisconsin and California enacted such laws. By 1940

permit the employment of most workers for the job for which they are best fitted. Those with a physical disability are usually given a special kind of work.

The medical department is under the direction of a physician and is staffed by graduate nurses and physicians. It is fully equipped with facilities for doing physical examinations, for caring for minor illness and surgical cases, and for emergencies. It may include rest rooms, physical therapy rooms, x-ray department, dental service, and laboratory service. The expense of maintaining this service is generally offset by greater efficiency and output by the employee and happier employees. Small industries usually hire a part-time physician and a full-time nurse. The activities of the medical department are numerous. They include all measures necessary to keep the working force at full strength: care for those who become ill or are injured while at work, periodic physical examinations, detection of disease and correctable defects in new and old employees, health education, safety programs, sanitation, hygiene, supervision of cafeterias, and recreation.

The scope of work of the industrial nurse is wide and variable Not only does she share in the responsibility of the medical department in caring for the equipment, records, and supplies, but she is the first to make contact with the worker. To become an industrial nurse, a nurse must have graduated from an approved nursing school, have training in public health, and have some knowledge of business and personnel management Such a background is necessary, for her work may involve every phase of industry. A large industrial plant is a small community Its members come to look upon the nurse as one to whom they bring their problems and seek advice She must be understanding and able to interpret the worker's problem in such a way that she can maintain good healthy industrial relationships with everyone She keeps close contact with the social agencies, clinics, hospitals, and health programs.

The nurse must be prepared to handle and care for any type of emergency. She helps the doctor during the physical examination. In smaller industries her responsibilities are increased, for she is frequently the only one present in the medical department She also makes appointments for patients requiring special tests, examinations, and treatments.

CHAPTER 36

SCHOOL HYGIENE AND SUMMER CAMPS

School hygiene is of the utmost importance for it concerns the health of approximately 35 million children. At the same time these children are our future citizens, and the welfare of the nation will rest upon their shoulders when they reach maturity. Since the state makes it compulsory that children attend school, it becomes its responsibility to supervise their education, health, and training. School hygiene offers the best opportunity of diagnosing diseases early when they can best be treated. This prevents the crippling effect and death in later life from diseases contracted during school age. Fortunately, our school system employs, in most cases, only individuals who have fulfilled the necessary qualifications and have a teacher's certificate. This has enabled the public health service to install a good school health service. The teachers, school authorities, and school boards are highly educated individuals and they see the value to be gained from teaching children personal and community hygiene, immunization, physical and health education, sanitation, medical and dental nursing care, prevention of communicable diseases, the necessity of modern school buildings.

Most of the school hygiene programs have been developed according to the needs required to promote the health of the school children through health service A workable program should include these four aspects: (1) sanitary school building, (2) medical, dental, and nursing care, (3) health education and training, and (4) physical education and training.

The school health service must employ specialists in all branches of medicine in order to fulfill its purpose. The personnel should include doctors, dentists, nurses, psychologists, psychiatrists, health and physical educators, and dieti-

some twenty-three states had enacted occupational disease legislation.

The Workmen's Compensation Law provides for a compensation for illness or an injury resulting from work. The employee is paid at intervals for a specific length of time. In most states the regulations provide for hospitalization and medical care. For those who are totally disabled, certain compensations are set aside for their care. In the case of death, the beneficiaries receive a prescribed compensation. In combination with these laws most states have enacted industrial health insurance which places the employer's liability with the state or a private insurance company. Such enactments have removed all unnecessary delay in pay and court proceedings with the end result of better feelings between the employee and employer.

Industrial hygiene has come to cover such a large group of people that it has become necessary for the state to take part in the protection and promotion of the health of the worker. As industry increased in size, state bureaus of labor and industry had to be formed. Since each state is sovereign, it has the power of forming its own regulations and programs of industrial hygiene. The industrial hygiene program in most states is under the control of the state health department or an industrial medical board especially appointed by the governor. The industrial hygiene program should include a staff of men with specialized training in such fields as medicine, chemistry, and engineering Inspectors should be appointed to investigate all industries for failure to carry out the sanitary, safety, and employment rules.

The state is responsible for giving advice and consultation service to industry and labor, for carrying on special studies and research concerning industrial poisons, health of the workers, and employment, and for enforcing protective legislation.

In 1914 the Division of Industrial Hygiene became a part of the United States Public Health Service. Its chief functions are aid and advice to the states in forming industrial hygiene programs, investigation of all problems dealing with the health of the worker, and service to all other bureaus and departments, such as the Department of Labor and Bureau of Mines, that may seek advice on industrial hygiene problems.

buildings for the very young are only one story high. This removes the hazards of stair climbing, fatigue, and falls. The buildings that house the older children have two or three stories.

All buildings should be made of fireproof material with enough fire escapes to permit evacuation of all the pupils within a few minutes. They should be equipped with heavy fire doors which would prevent fire from spreading from one room to the next and with fire hoses and sprinkler systems. *The instructors should have a fire drill at least once a week* so as to keep the students prepared for an emergency. Such precautionary measures ensure an orderly exit from the building if a fire should occur.

Classroom temperature should be maintained at 68 to 70 degrees F This is important, for high temperatures tend to make the pupils sleepy, uncomfortable, and susceptible to colds. During the winter months, exhaust fans and ventilators are necessary to remove the foul air and bring in fresh air from the outside.

Proper lighting is essential. The windows should be large enough to reach the ceiling and wide enough to permit light to cover a wide area The desks should be placed so that the light falls over the left shoulder and arranged to eliminate glare. To increase illumination the walls can be painted white or high-gloss yellow These colors will reflect 75 to 90 per cent of the light that strikes their surface

The desks should be of the adjustable type This enables a pupil to maintain a good posture while at work Students who are disabled because of poor hearing or eyesight *should* be given seats at the front of the room.

The chalkboards are black because this color eliminates glare and gives greater contrast between the various colors of chalk used for writing.

Drinking fountains of the *bubbler* type or those that project the stream of water at an angle are the *most satisfactory*.

School toilets are always a problem. Close supervision is necessary, for the children must be taught their proper usage. The toilets for the boys and girls should be separated. Adequate privacy should be provided by enclosing the stools with walls and a door. Soap, water, and towels should be within easy reach and conveniently placed to encourage their use.

tians. It is most important for a child between the ages of 6 and 14 to have the proper teachings and experiences in health education.

School Buildings.—If children are to be taught sanitation, the environment in which they receive their education must be sanitary. Good hygienic surroundings constitute an example and keep the children happy. Such principles apply mainly to the construction of the school building and its playgrounds. For children to take pride in their school, the teachers, janitors, and principals should set a good example for the pupils. This will make the children help keep the buildings and playground clean.

The early schools were of poor construction and were small. Most were built of wood. In most cases the school consisted of only one room which housed all the grades at the same time. Only one teacher was hired to instruct the various classes. Heat and ventilation were unsatisfactory and the room was either too hot or too cold Heat was provided by a wood stove. The drinking water came from a well at which a common drinking cup was used. The privy was the only place available for the care of the waste. Many such school houses are still being used in rural districts. It is hoped to replace them with modern buildings as soon as possible. It would be helpful if the numerous rural schools were consolidated, in strategic areas. However, this would bring more children in contact with each other. This would necessitate better sanitary methods for disposal of waste, hygiene programs, and better heating and ventilation to prevent the spread of disease (particularly childhood infections such as measles or mumps).

The modern school buildings have been built after complete study by architects, construction engineers, and health authorities. This applies to all schools from the single room country school to the large city schools The principles of sanitation are the same for all schools regardless of size The size of the building is dependent upon the population of the area it will serve and the ages and number of children in that district. Thickly populated areas will require several schools, while suburban areas may need only one building Most cities have built the kindergarten and grade schools together and have placed high schools at a separate location. In general, the

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The water basins and toilets should be placed at various heights so as to accommodate the children of different ages. Their number must be large enough to prevent crowding.

A school should be built in an area that is away from the main business center and traffic and noise. A large plot of land is essential to provide enough playground and an athletic field. All these things are conducive to physical education which help develop the body as well as the mind.

Through proper training and good examples the students can be made to feel responsible for the care of the school building and the playground.

Medical, Dental, and Nursing Care.—This service is extensive, for the pupil is under constant observation for development of any type of medical or dental defects. The children are examined at periodic intervals (6, 10, and 14 years of age) for the presence of rheumatic fever or heart disease, tonsilitis, malnutrition, mental defects, bone deformities, etc. The medical and dental examination should be complete. If possible, the parents should accompany the pupil during the examination to give the history. Chest x-rays, tuberculin tests, and the other vaccinations are given to those who have not been immunized.

During the physical examination, the teeth are checked by a dentist. He will make or advise the type of correction needed.

It is the responsibility of the teacher to make a daily inspection of her pupils for evidence of infection such as malaise, feverishness, skin rashes, or unusual pallor. If any of these are present, the pupil should be sent to the medical dispensary where he is seen by the school nurse. If necessary, the child is sent to the school physician or the family doctor. After this examination or after recovery from an illness, the child must obtain a health certificate from the physician stating that he is well and no longer infectious

Health Education and Training.—The teacher is the principal source of information for the children. Teaching hygiene and training the children to perform the necessary routine tasks is her responsibility. She should make the children aware of the necessity for cleanliness and sanitation She should develop

methods that will consciously make the children want to participate in the health activities. This can be done by allowing the children to keep their own health charts. She can set up demonstration classes showing the proper use of the toothbrush, soap and water, and towels. It is also her function to check the temperature of the room, maintain proper lighting, and help the children at recess.

The teacher should be trained to recognize the common symptoms of disease so that she can cooperate with the school and health authorities and parents and doctors and nurses in carrying out the health program.

Physical Education and Training.—All schools should have a playground that is large enough to accommodate the ordinary children's games. If possible, an indoor gymnasium should be available for use during the winter months. Physical training is now a part of the regular school curriculum in most states. Each pupil is required to take part in some sort of physical activity. It has been well shown that physical training develops character and good habits, provides relaxation, improves health, and develops muscles, and it will correct some physical defects

The school nurse is indispensable to the school health program. She is usually the first person especially trained in medicine who sees the sick pupil. She is the link between the school doctor and the parents. She is the instructor and guide that directs the health program under the supervision of the school physician Her functions are numerous and should include home visits, control of communicable diseases, aid to the sick and injured, assistance with the physical examinations, daily visits to the school clinics, keeping all the health records, supervision of the lunch rooms, advice on health problems, and inspection of schools.

Summer Camps.—With the development of towns and cities it became necessary to build temporary quarters first and then permanent living establishments. The urban youth of today is raised in a confined district. Arising from the need for physical education such as swimming, tennis, baseball, hiking, boating and companionship, summer camps have been developed. The largest are the Boy Scout and the Girl Scout

summer camps which are all over the United States. There are also numerous private camps for children. Other groups to open summer hotels were the Young Women's and Men's Christian Association (Y.W.C.A. and Y.M.C.A.).

Camps set up strictly for financial gains are the tourist camps, strung along every American highway. They may be found singly or as a group with all the modern conveniences of living, including stores, theaters, recreational centers, and cafes.

Naturally these camps have introduced many sanitary problems. To deal with these, most states, cities, and local communities have passed strict regulations for the operation of summer camps. Each owner is required to have a license before he can open his camp. He must submit building plans which include the methods to be used for the disposal of wastes and the piping of water. It is the responsibility of the public health department to make inspections to ensure the public a safe water supply and healthful environment.

CHAPTER 37

MEDICAL CARE, SERVICES, AND COST

Introduction.—Surveys by the Committee on Cost of Medical Care and the National Health Survey made by the United States Public Health Service show that a high percentage of the people of the United States do not receive adequate medical care.

The National Health Survey obtained its information by a house-to-house canvass of more than 700,000 urban homes which included eighty-three cities and twenty-three rural areas in eighteen different states between November, 1935, and March, 1936. It was concerned with finding out such things as the general condition of the nation's health, the duration of an illness, kind of illness, medical care received, economical and social factors resulting from illness, and chronic and debilitating illness and accidents which keep people from school and work

It was found that the incidence of illness lasting for one week or longer was 57 per cent higher among families with an income below $3,000. In this same group, acute and chronic illnesses were more frequent Also a higher percentage of persons in the low income class were ill with diseases of the lungs, bones, gastrointestinal tract, and nervous system and disabilities from accidents acquired during work This made it evident that the families in the lower income groups needed more medical care than do the more affluent classes

Furthermore, facts about how the public spends its money show that the average American spends more for his automobile, movies, tobacco, and alcoholic beverages than for medical care.

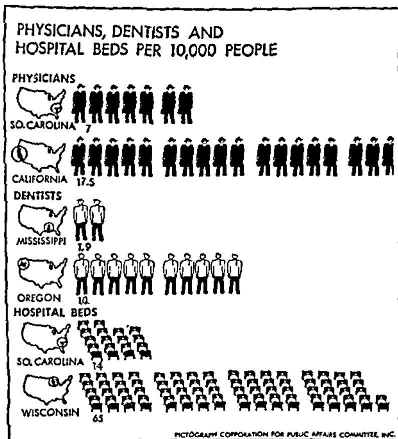
The distribution of the doctors in the United States is uneven. Most of the doctors, dentists, and nurses remain in the large cities, while a relatively small number go into the rural areas.

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disposal, and fly and mosquito control would decrease the incidence of many diseases. Many counties in this country cannot afford to employ health officers and sanitary engineers. Help from the Federal Government through state and local

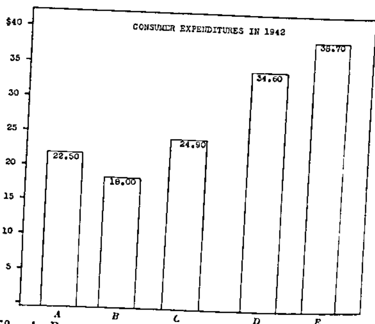


per 10,000 people. -sing, and hospital 1,431 people, while is one hospital bed Wisconsin (From Winslow, C. E. A. Health Care for Americans, Public Affairs Committee, Inc., New York, N. Y.)

units is necessary in many places. According to the United States Public Health Service,* 5,000 communities need new

*Wartime Health and Education, Interim Report from the Subcommittee on Wartime Health and Education to the Committee on Education and Labor of the U. S. Senate. Senate Subcommittee Report No. 3, Government Printing Office, p. 7, Jan., 1945

The 1950 directory of the American Medical Association gives a list of 201,277 doctors; 159,967 (79 per cent) of these were engaged in private practice as compared to 14 per cent working in hospital clinics, 4 per cent retired, and 2.5 per cent doing other kinds of work. An analysis of their distribution shows that it varies from one area to another and from state to state. For example, in New York there was one physician to each 545 persons, while in Mississippi there was one physician to every 1,000 persons.



... otal medical expenses. ... capita expenditure for ... ecreation; *E*, per capita ... from Survey of Current ... ommerce.)

The distribution of the hospitals follows that of the doctors except in the case of hospitals for tuberculosis and mental disease. In 1939 there were approximately 5,000 hospitals with a capacity of 489,178 beds. Many rural areas and small towns are without hospital facilities, public health officers, public health nurses, and sanitary engineers

The big problems in many rural areas is primarily economic rather than medical; for example, the proper supervision and protection of water, milk, and food supplies, adequate sewage

included. This Bill provided for an increase in Federal old age survivors and permanent disability insurance; changes in unemployment compensation allowances were suggested; new provisions were made for Federal medical and hospitalization benefits; and provisions were made for a system of medical care, including laboratory and hospital benefits, to every person insured under the Act and to their wives and children and to certain other groups. The Surgeon General of the United States Public Health Service was to administer the program. It was to be financed by a 12 per cent payroll tax for incomes up to $3,000 with a 7 per cent tax on the self-employed. This bill died in Committee.

In 1945, the second Wagner-Murray-Dingell Bill was proposed. While it was more extensive than the first, it reduced the payroll tax to 8 per cent and the tax on self-employed to 5 per cent, while it increased the taxable amount to $3,600. This bill never came to a hearing In November, 1945, President Truman sent his Health Message to Congress. In this, five basic problems were presented *

1 The number and distribution of doctors and hospitals.
2. The need for the development of public health services and maternal and child care.
3. Medical research and professional education.
4 The high cost of individual medical care.
5. The loss of earnings when sickness strikes.

The third Wagner-Murray-Dingell Bill was introduced into Congress in November, 1945 This Bill called for national compulsory sickness insurance and covered most of the points of the second bill but was not clear about the taxation necessary to finance the program.

The Fulbright-Taft Bill of 1947 (Senate Bill 140) and the Taft-Smith-Ball-Donnell Bill of 1947 (Senate Bill 545) are other bills pending in this field. Senate Bill 545 provides for the establishment of a national health agency to be administered by a national health administrator who would be a doctor and under whom all the health activities of the Federal government would be centralized. This bill also provides for complete medical and hospital care for the indigent and for partial payment for those unable to pay the total cost.

* National Health Program Message from the President of the United States. November 19, 1945 House Document 3

water systems, 7,700 communities with a population of 9,000,000 need new sewage systems, and 2,800 incorporated communities with a population of 25,000,000 have no sewage facilities at all.

In all discussions of the adequacy of medical care, the education of the public in matters of health is often neglected. Public health nurses and doctors are all too aware of the fact that often people do not know of the health facilities available to themselves and their families and if they do know they often do not avail themselves of them. Opportunities for free vaccination, free x-ray, free blood tests, and treatment are often not used by the general public. Why the patient often will not follow health instructions after he seeks advice is still an unsolved problem.

Governmental Plans and Programs.—As long ago as 1915 a *Model Sickness Insurance Bill* was drawn up, and between then and 1921 a number of states introduced bills for state sickness insurance, but in all instances they were defeated. The Sheppard-Towner Act in 1921 provided Federal aid for maternity care through those states passing enabling legislation It was repealed after eight years. As a result of the National Health Survey (p. 497), a National Health Conference was held in Washington in 1938 where proposals to increase Federal appropriations for health, and where plans to establish some form of national sickness insurance were made The Social Security Act of 1935 encouraged the formation of county health departments, with the United States Public Health Service working through state health departments. Some of the health activities provided for under this and the revised Act of 1938 are under the supervision and must meet standards set up by the Children's Bureau (Aid to Crippled Children, etc.).

The first national bill for compulsory sickness insurance was introduced in the Senate in 1939 and is known as the *First Wagner Bill.* Hearings were held but no action was taken. In 1943 the first Wagner-Murray-Dingell Bill was introduced. This bill was the most comprehensive plan for national compulsory sickness insurance presented in this country and would have placed the administration of the program under the Social Security Board; more governmental control over hospitals, doctors, patients, medical research, and education were

included. This Bill provided for an increase in Federal old age survivors and permanent disability insurance; changes in unemployment compensation allowances were suggested; new provisions were made for Federal medical and hospitalization benefits; and provisions were made for a system of medical care, including laboratory and hospital benefits, to every person insured under the Act and to their wives and children and to certain other groups. The Surgeon General of the United States Public Health Service was to administer the program. It was to be financed by a 12 per cent payroll tax for incomes up to $3,000 with a 7 per cent tax on the self-employed. This bill died in Committee.

In 1945, the second Wagner-Murray-Dingell Bill was proposed. While it was more extensive than the first, it reduced the payroll tax to 8 per cent and the tax on self-employed to 5 per cent, while it increased the taxable amount to $3,600 This bill never came to a hearing. In November, 1945, President Truman sent his Health Message to Congress. In this, five basic problems were presented.*

1. The number and distribution of doctors and hospitals
2. The need for the development of public health services and maternal and child care.
3. Medical research and professional education.
4. The high cost of individual medical care.
5. The loss of earnings when sickness strikes.

The third Wagner-Murray-Dingell Bill was introduced into Congress in November, 1945. This Bill called for national compulsory sickness insurance and covered most of the points of the second bill but was not clear about the taxation necessary to finance the program

The Fulbright-Taft Bill of 1947 (Senate Bill 140) and the Taft-Smith-Ball-Donnell Bill of 1947 (Senate Bill 545) are other bills pending in this field. Senate Bill 545 provides for the establishment of a national health agency to be administered by a national health administrator who would be a doctor and under whom all the health activities of the Federal government would be centralized. This bill also provides for complete medical and hospital care for the indigent and for partial payment for those unable to pay the total cost.

* National Health Program Message from the President of the United States, November 19, 1945 House Document 380 Government Printing Office, 1945.

There has been much controversy about these bills, and no settlement has yet been reached.

In 1947 the Hill-Burton Bill was passed. This was supported by many health, medical, and hospital groups, including the American Medical Association and the American Hospital Association. This bill provides for the expenditures of Federal funds through 1951 for the assistance of states in the building of hospitals and health centers in areas where need has been demonstrated through state surveys. The Federal government pays one-third of the cost, while the remainder is met by state, county, city, and private nonprofit hospital groups. Many of these hospitals have already been built and are doing a great deal to relieve shortages in hospital, health, and diagnostic facilities, particularly in rural and small town localities. These new hospitals should help to attract doctors and nurses to neglected areas.

Private Plans and Programs.—There has been a gradual but very definite growth of voluntary health insurance programs in this country. The need for some definite plan to meet the increasing cost of medical, nursing, and hospital care was dramatically demonstrated during the depression of the 1930's. At this time group hospitalization started under the now well-known Blue Cross Group Hospital plan. Over 25 million persons are now insured under Blue Cross hospital plans Many other individuals and families are covered by industrial insurance plans sponsored by employers

In the 1930's prepayment plans to meet the cost of medical care began to be developed by state medical societies. Washington and Oregon were the first states to sponsor such plans, followed by California in 1939 with the California Physicians' Service, and in 1940 the Michigan Medical Service was organized. This latter is the largest plan to date, with over 900,000 persons enrolled

In 1946 the Associated Medical Care Plans, Inc., was organized through the cooperation of the American Medical Association Council on Medical Service. The purpose is "to promote the establishment and operation of such non-profit voluntary medical care plans throughout the United States and Canada as will adequately meet the health needs of the public and preserve and advance scientific medicine and the high

quality of medical care rendered by the profession of the two countries."

At present all states have or are working on some type of prepayment plan. The Michigan Medical Service covers surgery, obstetrics, diagnostic x-ray, anesthesia, and limited hospital medical care. The cost is $1.80 per month for husband and wife and $2.60 per month for husband, wife, and children up to 19 years of age. (All fees quoted are subject to change.)

The California Physicians' Service is limited to groups of at least five employees, but in certain instances the self-employed and groups of fewer than five are admitted. It provides:

1. General surgical services in or out of the hospital.
2. Medical care, including laboratory tests, x-ray, and radium, and obstetrical care after ten months.

The costs per month are: men, $1.50; women, $2; subscriber and one dependent, $2.50; subscriber and two dependents, $3.75. (All fees quoted are subject to change.)

These plans sponsored by the medical societies usually cover individuals with income up to $3,600, but in many instances no income limit is enforced. The subscriber must usually be a member of a group and the enrollment covers his family.

In addition, many industries have health plans and insurance; some cover employees only; some include the family; some provide for hospitalization only, while others provide complete medical care. In 1946 a new plan in this field was the *Health and Welfare Fund of the United Mine Workers.* A fund is to be accumulated from wage deductions to be used for "medical, hospital and related purposes."

Collaboration and coordination between these various plans is necessary They have grown very rapidly during the past ten years and this development is likely to continue. The costs of medical care have increased due to the increasing use of hospitals and medical facilities by the people, the great cost of equipping and maintaining the modern hospital and health center, the increased cost of medical and nursing education, and the increased cost of adequately trained personnel. No program for good medical and nursing care and for adequate health instruction and supervision will be effective unless at the same time better housing, nutrition, and recreation are also provided

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QUESTIONS—UNIT VI

1. Sketch briefly the historical development of the public health movement.
2. What are the functions of the United States Public Health Service? the state and the city health departments?
3. What is meant by the term *vital statistics?*
4. Discuss the important aspects of home sanitation.
5. Why is sanitation of food and water supplies so important today? What are the measures taken in our country to make food and water safe?
6. Discuss hygienic and sanitary measures taken in industry; in schools; in camps.
7. Compare governmental and private plans for the improvement of medical care in this country.

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Angina—(1) severe and agonizing cardiac pain, (2) certain forms of throat infection.
Angioma—a tumor made up of dilated blood vessels.
Angioneurosis—paralysis or spasm of blood vessels because of disturbance of vasomotor system.
Anisocytosis—inequality in size of cells.
Ankylosis—*immobility of a joint.*
Anomaly—contrary or opposed to a general condition.
Anorexia—loss of appetite or decrease in the normal feeling of hunger.
Anosmia—loss of sense of smell.
Anoxemia—lack of oxygen in the blood.
[illegible] arterial blood lessened, but normal [illegible]
[illegible] destroying life, particularly of cer- [illegible]
Antibody—substance in body which reacts with antigen, thereby creating immunity.
Antigen—a substance which produces antibodies in a susceptible person.
Antitoxin—protein defending the body against toxins.
Anuria—lack of secretion of urine.
Aortic coarctation—narrowing of walls of aorta
Aphasia—loss of ability to read, write, speak, or understand written, printed, or spoken words.
Aphonia—*loss of voice.*
Aplasia—incomplete development of an organ or part of the body.
Apnea—tempo [illegible]
Arcus senilis— [illegible]
Argyll Roberts[illegible] ataxia in [illegible] contractic[illegible]
Artefact—artificial lesion produced by the patient.
Arteriosclerosis—hardening of walls of arteries.
Aschheim-Zondek—a test for pregnancy.
Aschoff's bodies—nodules found in the myocardium of rheumatic fever patients.
Ascites—abnormal accumulation of fluid in the peritoneal cavity
Aseptic—free from germs, sterile
Asphyxia—suffocation, suspended animation due to interference with oxygen supply to blood.
Asthenia—weakness, loss of strength
Atelectasis—*lack of air in lungs.*
Atherosclerosis—type of arteriosclerosis characterized by fatty degeneration of intima of large arteries.
Atony—lack of normal tone.
Atresia—failure to perforate
Atrophy—wasting of any part.
Atypical—differing from the normal or usual
Auscultation—listening for sounds made in body cavities, especially the chest and abdomen.
Avitaminosis—deficiency disease due to lack of vitamins.

B

Babinski's sign or reflex—extension of big toe on stroking sole of foot.
Bacteremia—presence of living bacteria in blood
Bacteriolysis—destruction of bacteria, usually by specific antibody.
Bacteriostasis—stopping bacterial growth.
Basal metabolic rate—amount of heat produced by an individual completely at rest 12 to 14 hours after eating a light meal.

GLOSSARY

A

Achlorhydria—lack of hydrochloric acid in gastric juice.
Achondroplasia—a form of dwarfism due to defect in formation of cartilage at the epiphyses of long bones.
Achromia—without color.

caused by an
y elimination

ient of bones of head, thorax, hands and feet; associated with hypertrophy of pituitary gland.
ACTH—initials commonly used for the new drug, adrenocorticotropic hormone

Adrenergic—stimulated by adrenalin.
Agglutinin—antil
capable of
Agnosis—absence
out loss of t
Agranulocytosis—absence of white blood cells
Albinism—congenital absence of pigmentation in skin, hair and eyes.
Albuminuria—albumin in the urine
Alkalosis—increase of alkalinity of body beyond normal due to excess of alkalies or to withdrawal of acids or chlorides from blood.
Allergy—undue sensitiveness to a certain substance or substances.
Amboceptors—antibody or immune substance uniting antigen and complement.
sence of menstruation
(starchlike substance) in tissues.
ence of oxygen.
pain.
ction of the body to a drug or foreign protein so that injection of a second dose results in a severe reaction.
Anasar
Andro
Andro
Anemia
Aneurysm—dilatation of artery due to pressure of blood on weakened arterial wall.

D

Debilitate—to produce weakness.
Decubitus—a bed sore.
Degeneration—impairment of structure or organ development into lower

[illegible] om its signs

[illegible] body

Differential count—determining the number of the different kinds of leukocytes in 1 cubic millimeter of blood
Diplegia—paralysis of similar organs or parts of the body on both sides.
Diplopia—double vision.
Dittrich's plugs—small particles of sputum composed of pus, bacteria, and fat

[illegible] ounts of urine.
[illegible] iount of urine secreted.
[illegible] lls of canal, especially of the colon
Drug fastness—resistance of bacteria to drug action.
Ductus arteriosus—channel between main pulmonary artery and aorta of

[illegible] an organ or part of the body.

E

[illegible] in the tissues.
[illegible] recording electrical cur-
[illegible] cording electrical fluctuations of brain.
Embolus—obstruction of blood vessel by foreign matter.
Emphysema—distention of tissues by air or gas, especially of lungs.
Empirical—the use of remedies based on experience that has been of benefit while a scientific explanation for the action of the remedy

[illegible] cavity.
[illegible] ase.

[illegible] cavities through natural openings.

Bell's palsy—paralysis of face affecting seventh cranial nerve.
Benign—not malignant, mild.
Bicornuate uterus—double uterus.
Bilirubin—orange or reddish colored pigment found in blood and tissues in jaundice.
Biopsy—excision of tissue for microscopic examination.
Blastomycosis—disease caused by fungi.
Blood dyscrasia—pathological condition of the blood.
[illegible] vall of blood vessel.
[illegible] disease.
[illegible] tion of pus.
Bronchogram—x-ray of lungs and bronchi.
Buerger's disease—disease of muscles and blood vessels of legs.

C

Cachexia—extreme wasting away, ill health, malnutrition.
Caisson disease—diver's paralysis.
Callous—thickening of horny layer of skin.
Carbon monoxide—a tasteless, odorless, poisonous gas.
Carbuncle—a localized inflammation of skin and deeper tissues ending in slough and marked constitutional symptoms.
Cardiac arrhythmia—irregular heart action.
Carrier—one who carries germs causing disease yet who is immune himself.
Catabolism—breaking down of food materials into simpler substances; [illegible], the other being anabolism.
[illegible] n psychic conditions.
[illegible] especially in medicine.
[illegible] at corners of the mouth.
[illegible] uicals having specific effect on bacteria.
[illegible] e of breathing characterized by [illegible] breathing increasing in depth and [illegible] and stopping altogether for 10 to [illegible]
[illegible] adolescent girls.
[illegible] bladder by x-ray.
Cholesterol—substance found especially in the bile and composing the greater part of gallstones
Chorea—muscular twitching due to rheumatic involvement of central nervous system
Chyluria—milky urine
Cirrhosis—liver disease characterized by thickening and hardening of its tissues
Coagulation—clotting
Coarctation—narrowing of vessel walls
Colitis—inflammation of large intestine.
Coma—state of profound unconsciousness from which individual cannot be aroused.
Complement—a substance in serum which combines with an amboceptor before it can complete the immune reaction.
Congenital—born with.
Constitutional—the body as a whole, disease which affects whole body.
Convulsion—paroxysm of contraction and relaxation of involuntary muscles.
Corrigan pulse—full, bounding pulse, water hammer pulse, associated with aortic insufficiency.

H

Halitosis—bad breath.
Hallucination—imaginary or false perceptions with no relation to reality.
Hebephrenia—syndrome of dementia praecox characterized by distor-

appearing in

s.

na in blood.

Hemophilia—increased tendency to bleed, inherited by males through the mother only.
Hemoptysis—spitting of blood.
Hemorrhage—abnormal discharge of blood either externally or internally.
Hemostasis—stopping of bleeding or of circulation.
Hermaphrodite—possessing genital and sexual characteristics of both sexes.

ther than the specific antigen.
naracterized by enlargement of

ent, chemical reaction, and tem-

of disease

hydrochloric acid in gastric

Hyperplasia—abnormal increase in normal cells without tumor formation
Hyperpnea—increase in the depth of breathing.
Hypertension—high blood pressure.

Endotoxin—bacterial toxin confined in the body of the bacterium

s in the sa

Epistaxis—nosebleed.

with anemia, edema, jaundice, and enlargement of the liver an

hagus.

n.

Extrasystoles—premature contraction of the heart while maintainin otherwise normal rhythm

Exudate—fluid that permeates through vessel walls into adjoining parts

F

art defect.

g blood and changed into fibri

tissue.

reak or crack

of an organ to a surface of the

bacteria are

G

Gangrene—death of a tissue

Gastric crisis—intense abdominal pain, paroxysmal in character peculiar to locomotor ataxia.

Gastritis—inflammation of stomach.

stomach.

ous system

cells.

aring on the edge of

wounds

Gumma—tumor in tertiary stage of syphilis.

M

Macrophage—large mononuclear leukocyte which engulfs other cells.
Malaise—general body discomfort and uneasiness often indicative of

ality.

noises
in the ears, and impairment of hearing.

the time it is excreted and by

r of disease to another organ
cancers.

usually associated with gastro-

Mongolian idiot—congenital idiocy associated with Asiastic features
Mononucleosis—unusually large number of mononuclear leukocytes in blood.

er

er.

N

Nephrolithiasis—presence of stones in the kidney.
Nephrosis—disease of kidney characterized by degenerative changes in kidney
Neuralgia—severe pain along a nerve.
Neutrophiles—leukocyte which stains readily with natural dyes
Night sweat—excessive perspiration at night
Nocturia—abnormal urination at night
Nocturnal polyuria—frequency of urination at night.
Normocytic anemia—anemia in which hemoglobin content remains normal.
Nyctalopia—night blindness.
Nystagmus—continuous involuntary movement of eyeball.

Hypertrophy—abnormal enlargement or growth of organ or part of body.

during which patient is susceptible to

on of hydrocloric acid.
about one's health.
cellular chromatin.
blood sugar.

Hypoproteinemia—decreased protein in blood.
Hypospadias—the urethra opening on the undersurface of the penis instead of the tip.
Hypotension—low blood pressure.
Hysteria—condition in which symptoms of disease, mental and physical, are presented without any disease being present.

I

Ichthyosis—"fish skin."
Icterus—pigmentation of skin with bile pigment; jaundice.
Icterus index—measurement of color of blood serum chiefly used as test of liver function by determining the color produced by bile pigments.
Idiopathic—refers to disease without recognizable cause.
Idiosyncrasy—individual or peculiar reaction, especially to drugs or other agents.
Immunity—state of being resistant, especially to infections, poisons, or parasites.
of food.
g of urine or passage of feces.
nterference with circulation.
of the skin.
part of intestine into another—usually

Ischemia—poor flow of blood through tissue or organ.

K

Keratosis—horny growth.
Kernig's sign—reflex contraction and pain in the muscles when extending leg after flexing it, a symptom of meningitis.
Koilonychia—fingernails spoon-shaped and brittle.
Kyphosis—humpback.

L

Labyrinthitis—inflammation of labyrinth (middle ear).
Laryngoscope—instrument for examination of larynx.
Leukemia—disease of the blood marked by persistent increase in number of white cells in the blood.
Leukocyte—white blood corpuscle.
Leukocytosis—increased number of leukocytes in blood, usually a sign of infection.
Leukopenia—unusual decrease in white blood corpuscles.
Leukoplakia—a white smooth area on the tongue or any mucous membrane.
Lockjaw—spasm of muscles of jaw, evidence of tetanus.
Lymphangitis—inflammation of the lymph vessels.
Lymphocytosis—increase in lymph cells.

Physiotherapy—treatment of disease by use of various physical forces of nature.
Pigmentation—local discoloration due to depositing of pigments.
Placebo—harmless substance given patient to satisfy his desire for medicine.
Plasma—liquid part of the blood or lymph.
Platelet—small structure in the blood concerned with the clotting

f pleura.

formed red

increase in number of red blood cells and in the total blood volume.
Polydactylism—excessive toes or fingers.
Polydipsia—extreme thirst.
Polyp—tumor, smooth and pediculated, especially on mucous mem-

disease.
Psychotherapy—treatment of disease by the personal influence of mental

peri-

Pyuria—pus in urine.

Q

Quarantine—regulations set up by law governing restrictions on persons or goods to prevent spread of disease.

R

Rachitic rosary—beadlike formation along ribs caused by rachitis.
Râles—bubbling sounds heard in bronchi on auscultation.

O

Osmosis—passage of solvent through partition separating solutions of different concentration.
Ossify—to turn to bone.
Osteitis deformans—inflammation of bone with thickening and hypertrophy of long bones and deformity of flat bones.
Osteomalacia—softening of the bones.
Otitis media—inflammation of the middle ear.

P

Paget's Disease—disease characterized by chronic inflammation of bones with thickening and malformation.
Palliative—treatment for the relief of symptoms, but not directed at the cure of the disease.
Palpation—examination by feeling with hands to the external surface of the body to determine evidence of disease.
ceptible to the patient.
rt of body.
ted with daydreaming and
as the host.
abnormal functioning of organic tissue at irregular intervals
Parenteral—occurring outside the intestines; usually applied to introduction of fluid or medication into the body by a route other than the mouth.
Paresis—partial, slight, or incomplete paralysis.
Paroxysm—sudden periodic attack or recurrence of symptoms; a convulsion of any kind
Pasteurization—arrest of fermentation in a liquid by heating it for 30 minutes at 60° to 70° C. without destroying its chemical composition.
Pathogenic—producing disease
Pathol
Percus
si
Periar
Peritoi
ium salts.
Pheochromocytoma—tumor in adrenal medulla causing increase in blood pressure.
Phobia—fear.
Photophobia—sensitiveness of the eyes to light.

Symbiosis—association of two different organisms depending on each

ange in normal body function

ease considered as a whole; the

s in the spinal cord.

T

Tabes dorsalis—syphilitic degeneration of posterior columns of spinal cord.
Tachycardia—rapid heart action.

m.

ther change (e g , concentration in blood necessary for excretion in urine).
Thrill—unusual tremor accompanying cardiac murmur and felt on

Transfusion—injection of one person's blood into another person
Transudate—substance passed through a membrane into body cavities such as serum
Trauma—wound or injury.
Tympanites—distention of abdomen by gas.
Tympanitis—inflammation of middle ear.

U

caused by failure of *kidney function.*
urinary tract after introduction of an

V

Vaccination—inoculation with protective vaccine.
Vaccine—any material used for preventive inoculation, especially bacterial preparation.

Rational—based on scientific reasoning.
Reflex—involuntary reaction in response to nerve impulse.
Resolution—disappearance of swelling or infection and return to normal.
Reticuloendothelial system—cell group found in liver, spleen, bone marrow, and hemolymph nodes characterized by having the same behavior to dyes and with common qualities.
Reticuloendothelium—tissue of the reticuloendothelial system.
Rh factor—antigenic factor in human blood.
Romberg's sign—lack of ability to hold body balance with eyes closed and feet close together.

S

...haracterized by loss of contact with ...ation of personality.
... arteries, inflammatory hardening,

... erythrocytes settle when an anticoagulant is added to blood.
Sensitization—being made sensitive to specific stimuli; making a cell sensitive to action of complement by uniting it with a specific amboceptor.
Septicemia—presence of pathogenic bacteria in blood.
Serology—science dealing with serum reactions, diagnosis, and treatment.
Serum—fluid part of blood when clot forms.
Serum sickness—allergic reaction following administration of foreign serum.
Sickle-cell anemia—form of anemia in which abnormal sickle or crescent-shaped erythrocytes are present in blood, occurs in Negroes.
Sigmoidoscope—instrument for examining the sigmoid colon.
Sign—evidence of disease found by the physician on physical examination
Simmonds' disease—atrophy of hypophysis of pituitary characterized by premature loss of hair and teeth, dry, wrinkled skin, low blood pressure and weak pulse, and psychosis
Sludge—the solid part of sewage.
Spasm—involuntary convulsive muscular contraction
Spastic paralysis—rigidity of muscles accompanying partial paralysis.
Specific gravity—weight of substance compared with equal volume of water.
Specific treatment—use of a remedy known to have a curative effect on certain disease.
Sphygmomanometer—instrument for measuring blood pressure.
Spina bifida—congenital defect in walls of spinal canal with protrusion of meninges.
Sporadic—occurring singly, used to describe few scattered cases of a disease.
Stagnant anoxia—decrease in oxygen from blood due to inadequate circulation.
Stasis—slowing up or stoppage of normal flow of fluids, especially of blood, urine, or in the intestinal canal

... l or duct
... color to feces

... ing respiration.
Stupor—a state of unconsciousness with reduced response to outside stimuli.

e best possible state until

imatic infection.
isms depending on each

normal body function

Syndrome—all the symptoms of a disease considered as a whole; the complete picture of a disease.
Syringomyelia—development of cavities in the spinal cord.

T

Tabes dorsalis—syphilitic degeneration of posterior columns of spinal cord.
Tachycardia—rapid heart action.
Teratoma—tumor containing embryonic elements of hair, teeth, etc.
Tetany—disease characterized by intermittent, painful muscle spasm.
Therapeutics—the treatment of disease
Thermolabile—changed or destroyed by heat.
"Threshold value"—the minimal stimulus which produces pain, or other change (e g, concentration in blood necessary for excretion in urine).
Thrill—unusual tremor accompanying cardiac murmur and felt on

sel resulting in

arge veins and

od platelets

clotting.

secretion.

is harmful if

able, origin

Transfusion—injection of one person's blood into another person
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U

Ulcer—open wound.
Uremia—toxic condition of blood caused by failure of kidney function.
Urography—x-ray of any part of urinary tract after introduction of an opaque substance.

V

Vaccination—inoculation with protective vaccine.
Vaccine—any material used for preventive inoculation, especially bacterial preparation.

air into cerebral

h an endoscope.

Virus—ultramicroscopic parasites, many of which pass through filters which retain bacteria.
Viscera—internal organs, especially those in abdomen.
Vocal fremitus—vibration of chest wall felt on palpation when patient is speaking.
Vocal resonance—sound heard on auscultation when patient is speaking.
Volvulus—twisting of bowel upon itself causing obstruction.
Vomiting—the forceful expulsion of stomach contents through the mouth.
von Graefe's sign—failure of eyelid to move down promptly with eyeball.

W

Wheal—small elevation in skin, white in center and red at edges, accompanied by itching, allergic skin reaction.

X

Xerophthalmia—dryness with inflammation and ulceration of the conjunctiva and cornea.

INDEX

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Q

R

T